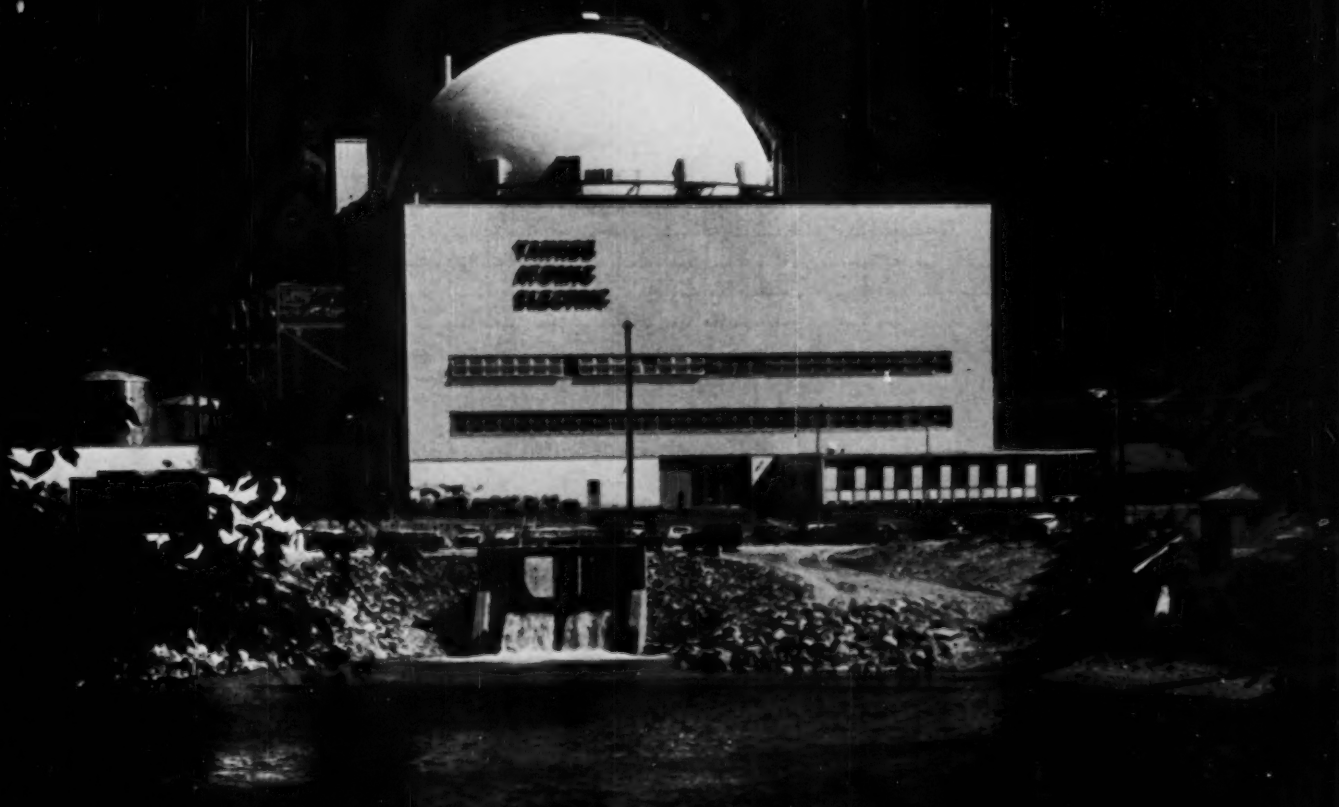
ELECTRICAL ENGINEERING

OCTOBER 1960



FEATURING

ADVENTURES IN ENERGY CONVERSION

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ACTUAL TESTS* PROVE

Allen-Bradley Standard Duty Push Buttons can be installed

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In accurately timed tests, Allen-Bradley standard duty push buttons required *about half the installation time*—on the average—than each of four other popular makes. This saving in installation time means "dollars" saved on the job.

How come only famous A-B standard duty push buttons possess this time and moneysaving advantage?

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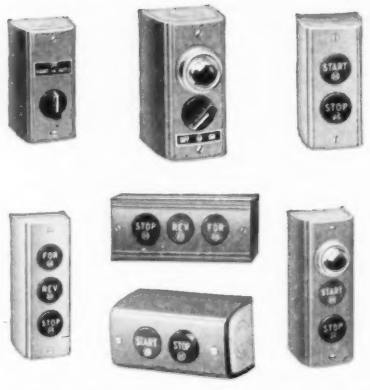
Your local A-B distributor has these Bulletin 800 push buttons *in stock*. Call him today—you'll save time and money on your next job.

**Using recognized standard duty push buttons, installations were made by an experienced electrician under identical conditions. He was not connected with Allen-Bradley Company in any manner.*



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QUALITY MOTOR CONTROL

ELECTRICAL ENGINEERING

OCTOBER 1960
Vol. 79, No. 10

THE COVER: Yankee Atomic Electric Company's nuclear powered generating station at Rowe, Mass., is the first such facility in New England. Westinghouse Electric Corporation designed and developed the reactor. Located along the Deerfield River in northwestern Massachusetts, the nuclear power plant has achieved criticality and is expected to begin full power operation this fall. Story on p. 878.

Contents

Institute Technical Groups — *W. R. Clark* — 793

Some of the past and present history of the major steps leading to the establishment of Institute Technical Groups

Adventures in Energy Conversion — *R. W. Porter* — 801

A broad view of the exciting technological opportunities awaiting exploitation in the realm of energy conversion

Elmer A. Sperry Centennial — *P. R. Bassett* — 808

A brief account of some of the accomplishments of Elmer A. Sperry whose 100th Anniversary is being commemorated in October

Special Positions for Person-to-Person, Collect, and Credit Card Calls — *L. Freericks* — 814

Description of the facilities and circuits introduced to handle the steady increase in telephone toll traffic

Insulation Control Measurement Consideration — *G. F. Lang* — 818

Problems involved in developing measuring techniques for the evaluation of insulation of large machinery are discussed

High-Voltage Static Eliminators for Teletypewriters — *J. A. Jonas, F. E. Hanscom* — 823

A device has been developed for the elimination of static charges from teletypewriter paper tape and rolls

The "Bucking Bronco" Motor as a Nonlinear Oscillator — *R. M. Goldwyn* — 828

Investigation of the "bronco" gives insight into many problems in the nonlinear analysis of both electrical and mechanical systems

Servo Control for Synchronized Conveyors — *A. E. Lewis* — 832

The electric controls for a conveyor system designed for use in the automotive industry are described

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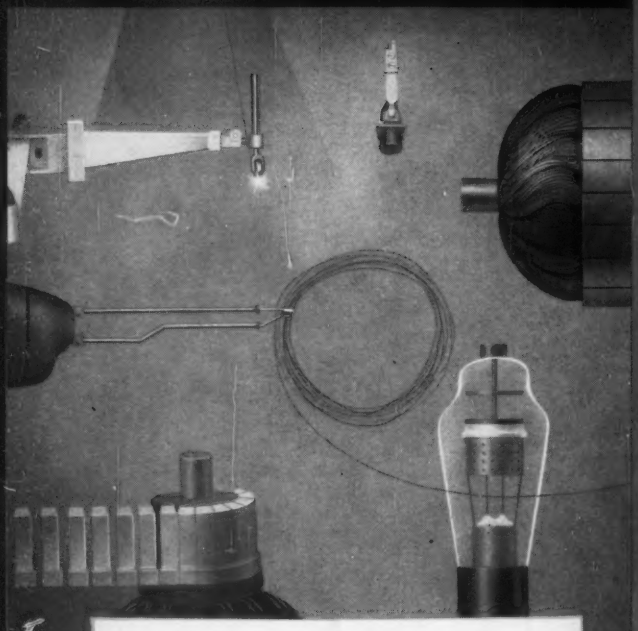

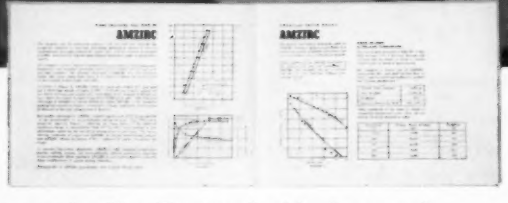

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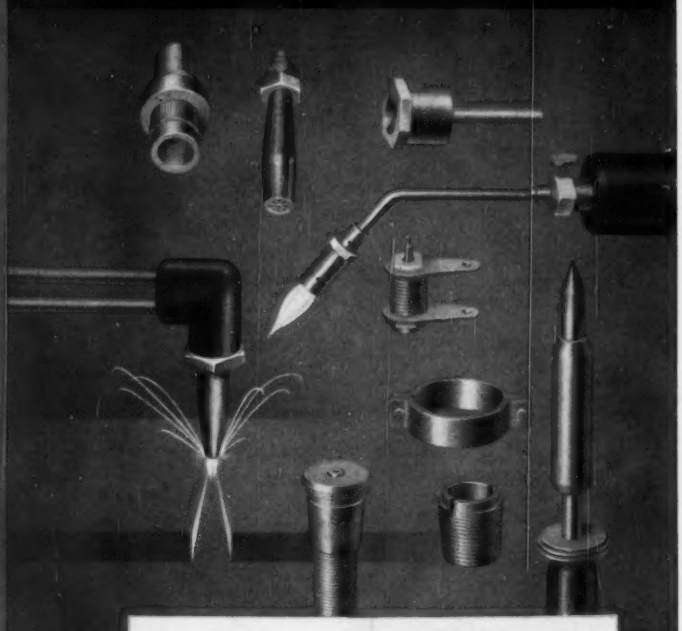

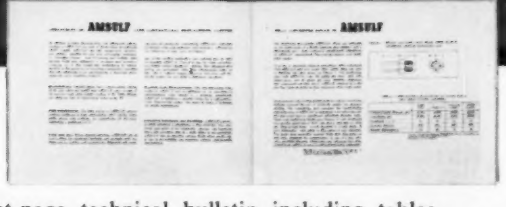

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LET'S TALK FUSE LINKS

Outwardly most fuse links look very much alike . . . but there the similarity ends! What, then, makes Kearney Fuse Links more dependable . . . more accurate than others? Let's start with construction. All Kearney Fuse Links feature LOW temperature fusible elements and de-ionizing fibre lined tubes. Temperatures inside fuse tube and cutout cartridge always remain well below the fibre charring point . . . even after prolonged service overloads. Thus, the all-important fibre is not impaired by excessive heat . . . fuse tube and cartridge retain their original strength and arc-quenching capabilities necessary for positive full-range fault interruption The exclusive de-ionizing fibre lining and extra strength of the Kearney fuse tube, in effect, make the Kearney Fuse Link a cutout within a cutout when interrupting fault currents up to 600 amperes.* Extra-long, tough, moisture and weather resistant tube provides a longer de-ionization path to clear low faults faster, more positively . . . will not warp or hang up in cartridge. Fuse tube and top terminal are securely joined to prevent loss of expulsion gas pressure Select components, rigid quality control, exhaustive laboratory and substation testing guarantee strict adherence of Kearney Fuse Links to published T-C curves. For positive system protection and accurate co-ordination . . . specify Kearney Fuse Links . . . Standard or Specialized.

*An average figure varying with different fuse ratings.

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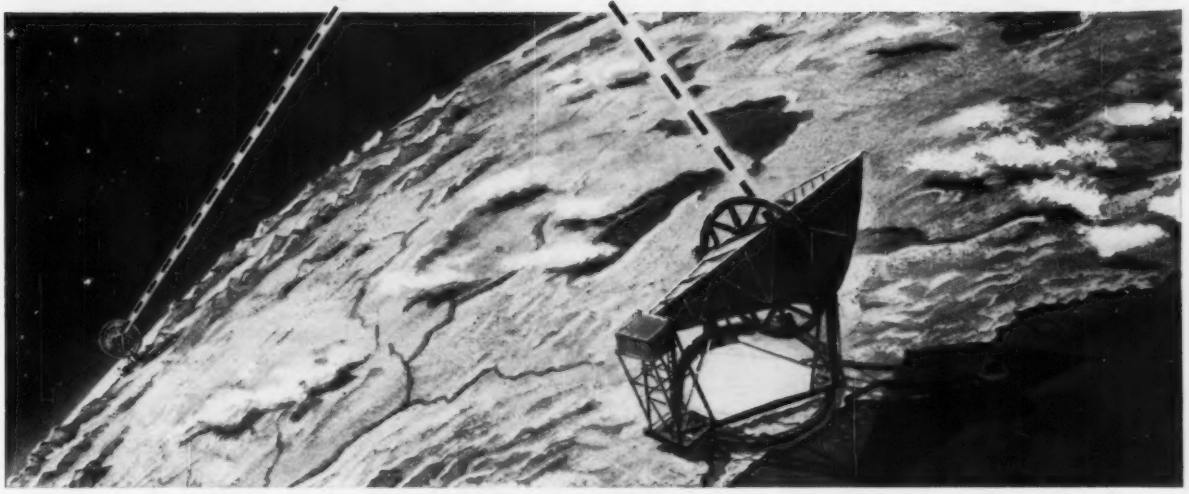
FIRST PHONE CALL VIA MAN-MADE SATELLITE!

"Project Echo" satellite went into a near-perfect circular orbit 1000 miles high, circling the earth once every two hours. Its orbital path covered all parts of the U. S.



BELL TELEPHONE LABORATORIES BOUNCES VOICE OFF SPHERE PLACED IN ORBIT A THOUSAND MILES ABOVE THE EARTH

Think of watching a royal wedding in Europe by live TV, or telephoning to Singapore or Calcutta—*by way of outer-space satellites!* A mere dream a few years ago, this idea is now a giant step closer to reality.

Bell Telephone Laboratories recently took the step by successfully bouncing a phone call between its Holmdel, N. J., test site and the Jet Propulsion Laboratory of the National Aeronautics and Space Administration (NASA) in Goldstone, California. The reflector was a 100-foot sphere of aluminized plastic orbiting the earth 1000 miles up.

Dramatic application of telephone science

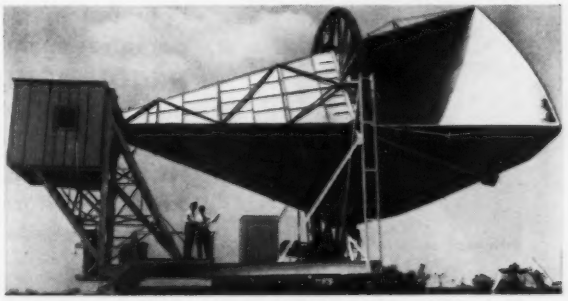
Sponsored by NASA, this dramatic experiment—known as "Project Echo"—relied heavily on telephone science for its fulfillment . . .

- The Delta rocket which carried the satellite into space was steered into a precise orbit by the Bell Laboratories Command Guidance System. This is the same system which recently guided the remarkable Tiros I weather satellite into its near-perfect circular orbit.

- To pick up the signals, a special horn-reflector antenna was used. Previously perfected by Bell Laboratories for microwave radio relay, it is virtually immune to common radio "noise" interference. The amplifier—also a Laboratories development—was a traveling wave "maser" with very low noise susceptibility. The signals were still further protected from noise by a special FM receiving technique invented at Bell Laboratories.

"Project Echo" foreshadows the day when numerous man-made satellites might be in orbit all around the earth, acting as 24-hour-a-day relay stations for TV programs and phone calls between all nations.

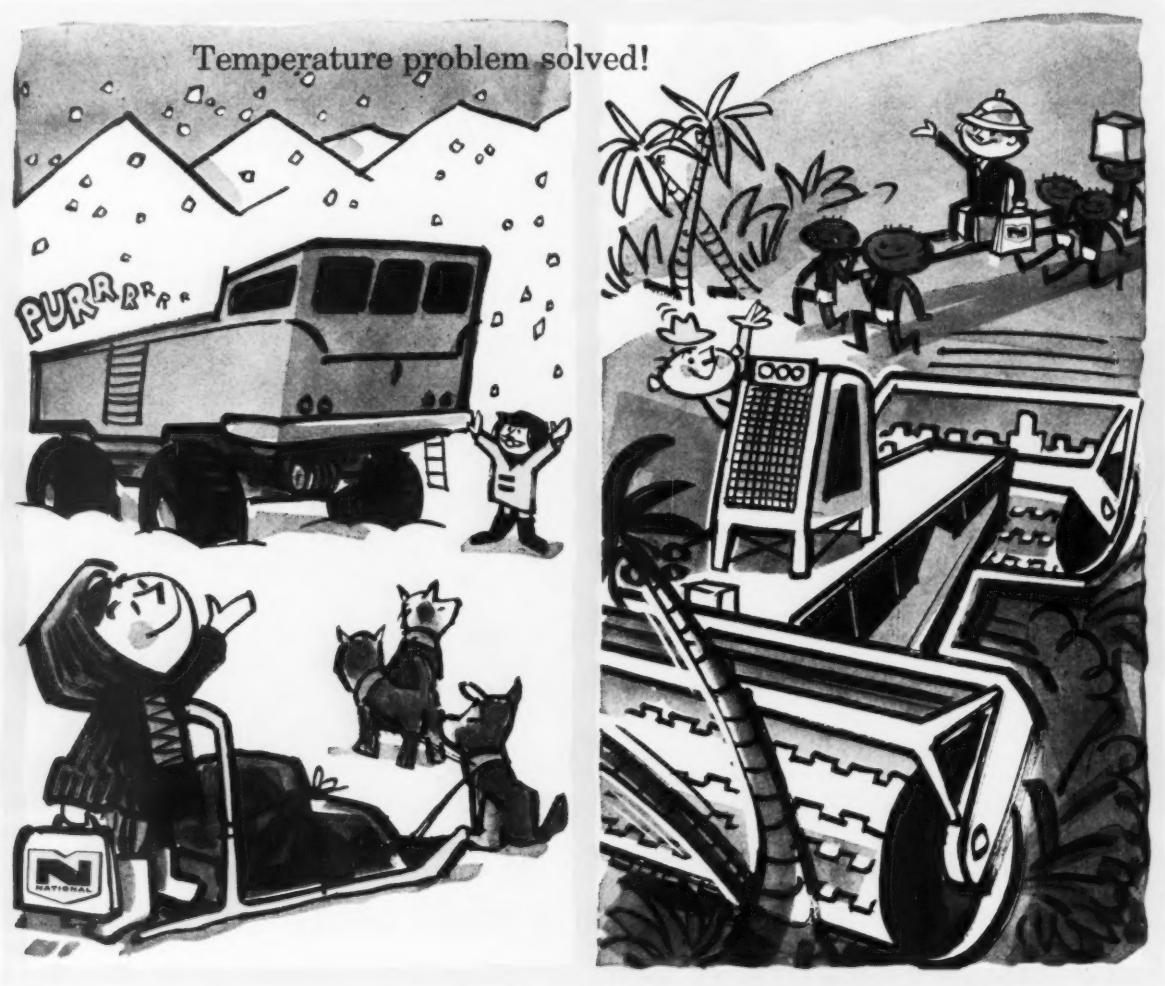
This experiment shows how Bell Laboratories, as part of the Bell System, is working to advance space communication. Just as we pioneered in world-wide telephone service by radio and cable, so we are pioneering now in using outer space to improve communications on earth. It's part of our job, and we are a long way toward the goal.



Giant ultra-sensitive horn-reflector antenna which received signals bounced off the satellite. It is located at Bell Telephone Laboratories, Holmdel, New Jersey.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



Idling at 70° below zero—or pushing at 127°

one NATIONAL brush fits both jobs!

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PROBLEM: This earth-moving equipment operated in rugged terrain where temperatures might vary 200 degrees.

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RESULTS: Excellent cold weather and tropical performance even where commutator speeds reach 5,000 RPM.

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New and Improved Products . . .

Annunciator . . .

A new signaling system featuring a miniaturized annunciator capable of indicating 100 different numbered signals has been designed for individual signaling without the necessity of installing large, unsightly annunciators. Signals are displayed on compact telescreen 7 inches square—small enough to be mounted into a desk top, pen stand, or small wall space. As soon as the signal is noted, it can be cancelled by pressing a reset push button, automatically releasing the next stored signal to appear on the telescreen annunciator. *Auth Electric Co., Inc., Long Island City 1, N.Y.*

Motion Detector . . .

Originally designed to prevent automobiles with automatic transmissions from creeping while idling in gear, this device is being offered to the general field of industry to sense motion or lack of motion in automated operations, and as a safety or warning instrument. Although designed to sense increments of rotary motion as low as ½ rpm, the component may also be used to detect linear motion by a simple conversion device. Possible ap-

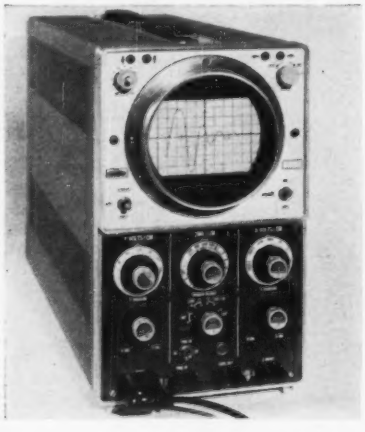
plications range from safety door switches for trains and buses to back-up detectors on conveyor lines. *Gaylord Products, Inc., 1918 Prairie Ave., Chicago 16, Ill.*

Gas-Turbine Power Plants . . .

Self-contained, automatically controlled gas-turbine power plants in ratings of 3,000, 7,000 and 12,000 kv have been designed for peaking, reserve capacity, or emergency operation to supplement the 22,000- and 44,000-kw peaking gas-turbine plants now available. The entire plant requires only a flat concrete-slab foundation approximately 3 feet thick, plus electrical and fuel connections. Complete installed cost of Enoco-Pac plants is approximately $80 per kilowatt, based on winter operation, or $100 per kilowatt for summer use. *Westinghouse Electric Corp., Box 2278, Pittsburgh 30, Pa.*

Storage Oscilloscope . . .

Oscilloscope patterns may be frozen instantly on the face of the cathode-ray tube for periods of minutes or days with this latest aid to scientists



and engineers, called the Storescope. A PIO phosphor instead of the conventional mesh type of storage tube is used to produce a dark trace on a light background. Since actual storage time is determined by ambient temperature and density of recorded trace, the image can be retained even if there is a line voltage failure. The instrument can serve as a storage scope or as a normal all-purpose oscilloscope, as desired. *Allen B. DuMont Laboratories Div., 750 Bloomfield Ave., Clifton, N.J.*

Miniature Memory Drum . . .

100,000 bits of information can be stored on a stainless steel drum that measures 3 by 3 inches and weighs only 6 ounces. Designed for airborne computers, the total assembly weighs 8 pounds, compared to 235 pounds for earth-bound devices. Spinning at 6,000 rpm, the drum builds up a micro-thin

layer of air over its surface. Slider bearings ride on this film staying only 100 millionths of an inch away from the drum, even under severe vibration. *International Business Machines Corp., 590 Madison Ave., New York 22, N.Y.*

Light Panels . . .

One of the many applications of light-emitting panels manufactured by this company, which recently entered the electroluminescent lighting field, is in the illumination of an AM/FM radio control panel equipped with a stereo system. Other uses will be in decorative lighting, illuminated dials, home appliances, highway signs, and safety devices. Merchandised under the trade name Panelray, the product will be initially available in five light-emitting colors of green, blue, yellow, orange, and white. *Radio Corp. of America, 30 Rockefeller Plaza, New York 20, N.Y.*

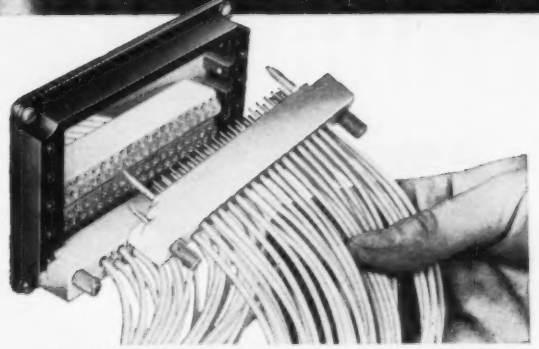
Temperature Cutout . . .

An accurate instrument that combines automatic protection against excess temperature with continuous temperature indication is available in two models. *N-34* shuts off when line voltage failure is encountered, while *N-30* continues to operate. Called Pyrotac, the device is primarily intended for use in conjunction with other controllers, but can also serve as the only control instrument on a process requiring complete shut-down after reaching a final preset temperature, or when the operator's attention is required after completion of a temperature cycle. *Alnor Instrument Co., 420 N. LaSalle St., Chicago 10, Ill.*

(Continued on page 22A)

HUGHES "VEST POCKET" AIR DEFENSE

interconnected with HYFEN® and STAPIN®



HYFEN-type connectors like those used in the "vest pocket" air defense system have pins and sockets tool-crimped on cable ends, snap-locked in inserts with wide range of configurations. HYFEN and STAPIN inserts are mounted in panels as required.

A highly mobile electronic air defense system insuring nearly instant destruction of hostile aircraft by coordinating antiaircraft missile firing at split-second speeds has modernized the field army's air defense capabilities. This "vest pocket" air defense, mounted in standard, heavy duty 2½-ton Army trucks, is another high-quality development of one of America's leading manufacturers of military electronic systems, the Hughes Aircraft Company.

This air defense system's complex circuits are interconnected with Burndy HYFEN and coax STAPIN connectors. Contacts are tool-crimped on wire ends at the workbench, then snap-locked into inserts on the job, reducing time and skill required to install and service, assuring dependable connections of measurable quality.

For HYFEN and STAPIN units and installation tooling engineered to your connection requirements, contact: OMATON division

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Alcoa aluminum patented integral web channel bus available in 8 sizes

You can now get **all** the advantages of aluminum integral web channel bus in a new broad range of sizes.

This patented* design, introduced by Alcoa in 1956, has been expanded to eight sizes, providing capacities from 2,800 to 12,000 amperes.

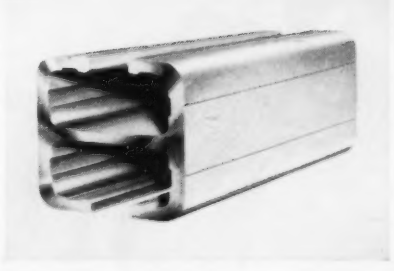
The web construction provides an integral shape for a bus conductor having unusual mechanical strength and high electrical efficiency. The large section modulus offers high structural strength to resist external loading and short-circuit stresses. The economical disposition of metal provides high current-carrying capacity at a low cost.

Moreover, you can make joints, taps, and splices by clamping, bolting, or welding. The table shows the sizes, capacities and weights from which you can choose to meet your exact needs.

Additional sizes can be designed to meet other specific needs. For complete information, contact your Rome representative. Or, if you'd like a copy of our "Alcoa Aluminum Bus Conductor Handbook," write: Rome Cable Division of Alcoa, Dept. 3-100, Rome, N. Y.

*PATENT NO. 2,904,621

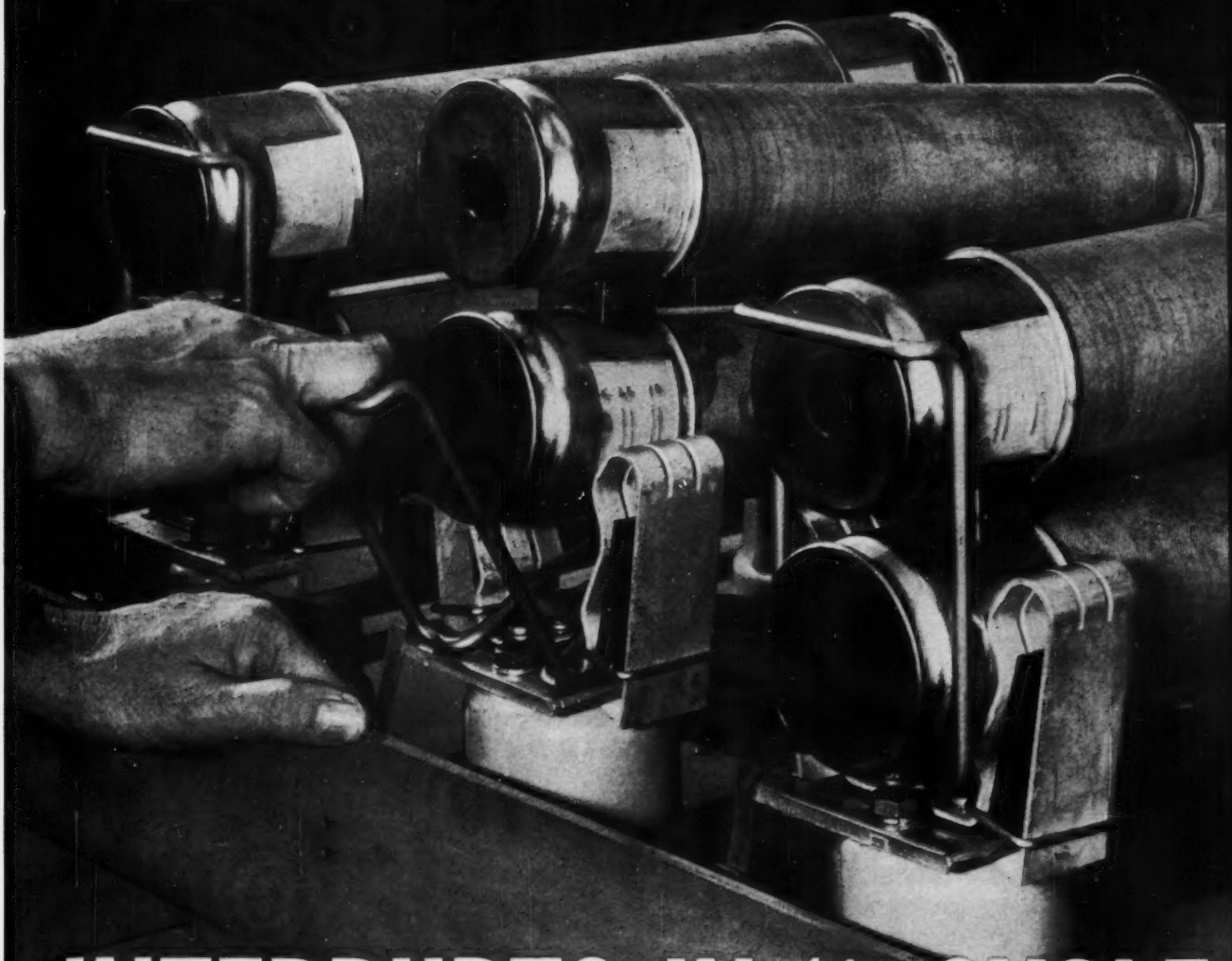
Size	Nominal Current† (amperes)	Wt./ft. (lbs.)
4 x 4	2,800	5.4
4 x 6	3,500	7.1
5 x 6	4,050	8.9
5 x 8	5,000	11.7
6 x 6	5,000	14.2
8 x 8	7,000	19.0
11 x 11	10,000	31.0
12 x 12	12,000	38.0



†Based on 30°C rise above 40°C ambient still air

ROME CABLE
DIVISION OF **ALCOA**

NEW DRAW-OUT DESIGN
LIMITAMP* MOTOR CONTROL



INTERRUPTS IN ½ CYCLE

Rated 2300- to 4600-volts for a-c motors up to 3000 hp.

Here is performance you can count on . . . to start, stop and protect your motor under *your* environmental conditions!

General Electric's new draw-out Limitamp control is designed to interrupt in the first ½ cycle. Current is limited in the first ¼ cycle. EJ-2 fuses—the standard of excellence—give you this dependable short-circuit protection.

The new draw-out contactor is designed to give outstanding performance under all conditions of load—from small motors running light to large motors at "locked rotor." This improved performance comes from a new blow-out structure and an improved arc chute with superior extinguishing action.

The new contactor also meets a 60-kv base impulse level. Performance of the entire design has been exhaustively tested in General Electric's high-voltage laboratories . . . and, complete design coordination of bus, cable, current transformers, contactors, fuses, insulators and overload relays means top protection for men and equipment!

Ask your G-E Apparatus Sales Engineer or Agent about other advanced-design performance, maintenance, installation and operation features of new Limitamp control. Or, write Sect. 783-12, General Electric Co., Schenectady, N. Y. for Bulletin GEA-6893. Industry Control Dept., Salem, Va.

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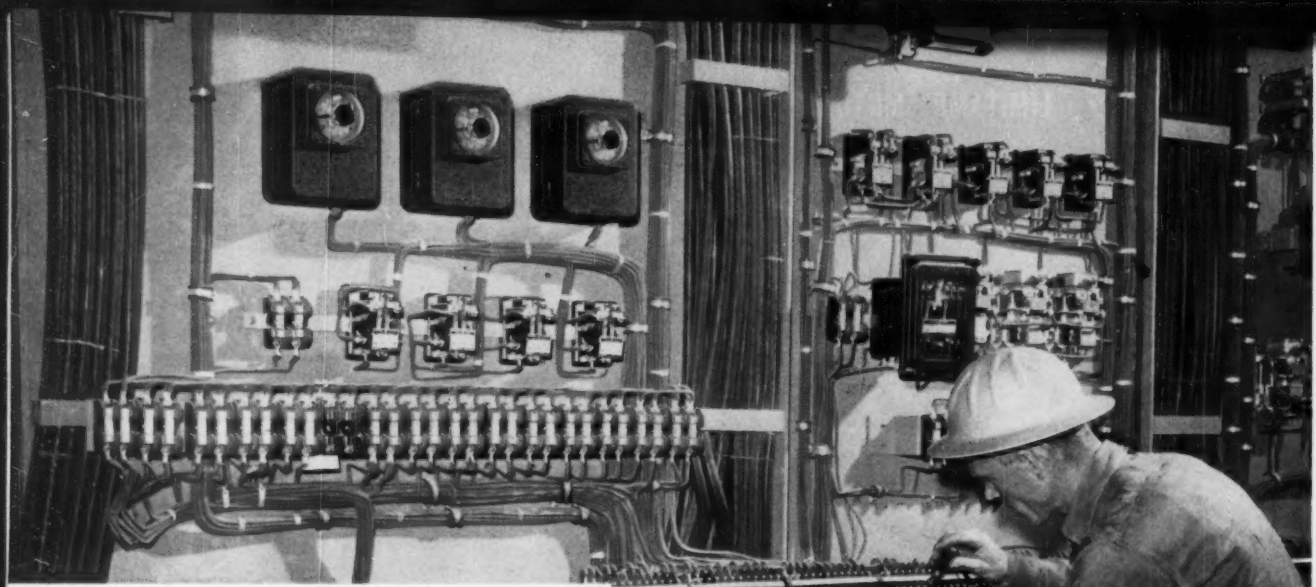
GENERAL ELECTRIC

* Reg. Trade-mark of General Electric Company



CABLE'BILITY ON THE JOB in the control room of McMeekin Station. Okolite-Okoprene 600-volt and 5000-volt cables were used for all power, control and lighting circuits for both units of the station, assuring long, dependable service.

MODERN COAL-HANDLING FACILITIES at South Carolina Electric and Gas Company's new McMeekin Station—one of the most efficient and economical steam electric generating stations in the world. The new station, producing 275,000 kilowatts of power, uses only 15 cubic feet of space per kilowatt.

Cable'bility at work

Over a Million Feet of Okolite-Okoprene in South Carolina Electric's new McMeekin Station

Cable'bility (kā'ble·bil'·i·ty) *new word.* *Noun.* **1.** Ability to design and manufacture electrical cables that give outstanding performance. **2.** Having long background and wide experience in cable research and application. **3.** Possessing keen understanding of customers' problems. Implies eagerness to serve faithfully and dedication to progress. **Syn.** The Okonite Company.

More than a million feet of 600-volt and 5000-volt Okolite-Okoprene cables are installed in South Carolina Electric & Gas Company's new McMeekin Station, engineered by Gilbert Associates, Inc., of Reading, Pa., installed by T. D. McClure, Jr. Co. of Atlanta, Ga., formerly Miller Electric Co. of Carolina.

Okolite-Okoprene cables had previously shown satisfactory service records in power, control and lighting circuits at South Carolina Electric's second largest steam electric generating facility, Urquhart Station.

The McMeekin installation—one of the world's most efficient and economical generating stations, providing 275,000 kilowatts of power while using only 15 cubic feet of space per kilowatt—uses a variety of Okolite-Okoprene cables. Multiconductor control and power cables were used almost exclusively throughout the plant and switchyard and to connect the coal handling facility and adjacent Hydro Plant. Multiconductor constructions were used to increase mechanical protection since most cables were installed in common in-the-floor or in-the-ground raceways covered by steel plates or concrete slabs.

For the full story on Okolite-Okoprene, write for Bulletin EG-1085. The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, N. J.

***where there's electrical power . . . there's* OKONITE CABLE**

7229-A

Anaconda American Brass Company
Waterbury 20, Conn.

Please send me a copy of your 8-page booklet which details properties of your four free-cutting, high-conductivity coppers, and suggested machining practices.

Name.....

Company.....

Street.....

City.....**Zone**.....**State**.....

4 ways to cut the cost of high-conductivity parts

There are now four free-cutting, high-conductivity Anaconda coppers that broaden the combinations of mechanical, physical, and fabricating properties available for boosting production and cutting costs of high-conductivity parts. They are furnished chiefly in rod and bar, but are available also as extruded shapes and, except for the leaded coppers, die-pressed forgings of simple design. All have good cold-working properties.

Leaded Copper-126 and Deoxidized Leaded Copper-129 have slightly higher electrical conductivity—98% IACS annealed, 95% IACS, minimum. The difference between them is that Alloy 129, being deoxidized, is not subject to hydrogen embrittlement when annealed or furnace-brazed in reducing atmospheres. Neither leaded alloy is recommended for hot working.

Tellurium Copper-127 and OFHC* Sulfur Copper have an electrical conductivity rating of 95% IACS annealed, 90% minimum. Both may be extensively hot worked and neither is subject to hydrogen embrittlement. Tellurium Copper-127 has the advantage of retaining its mechanical properties at temperatures higher than those tolerated by the other free-cutting coppers—and hence is widely used in the welding and cutting-tip field.

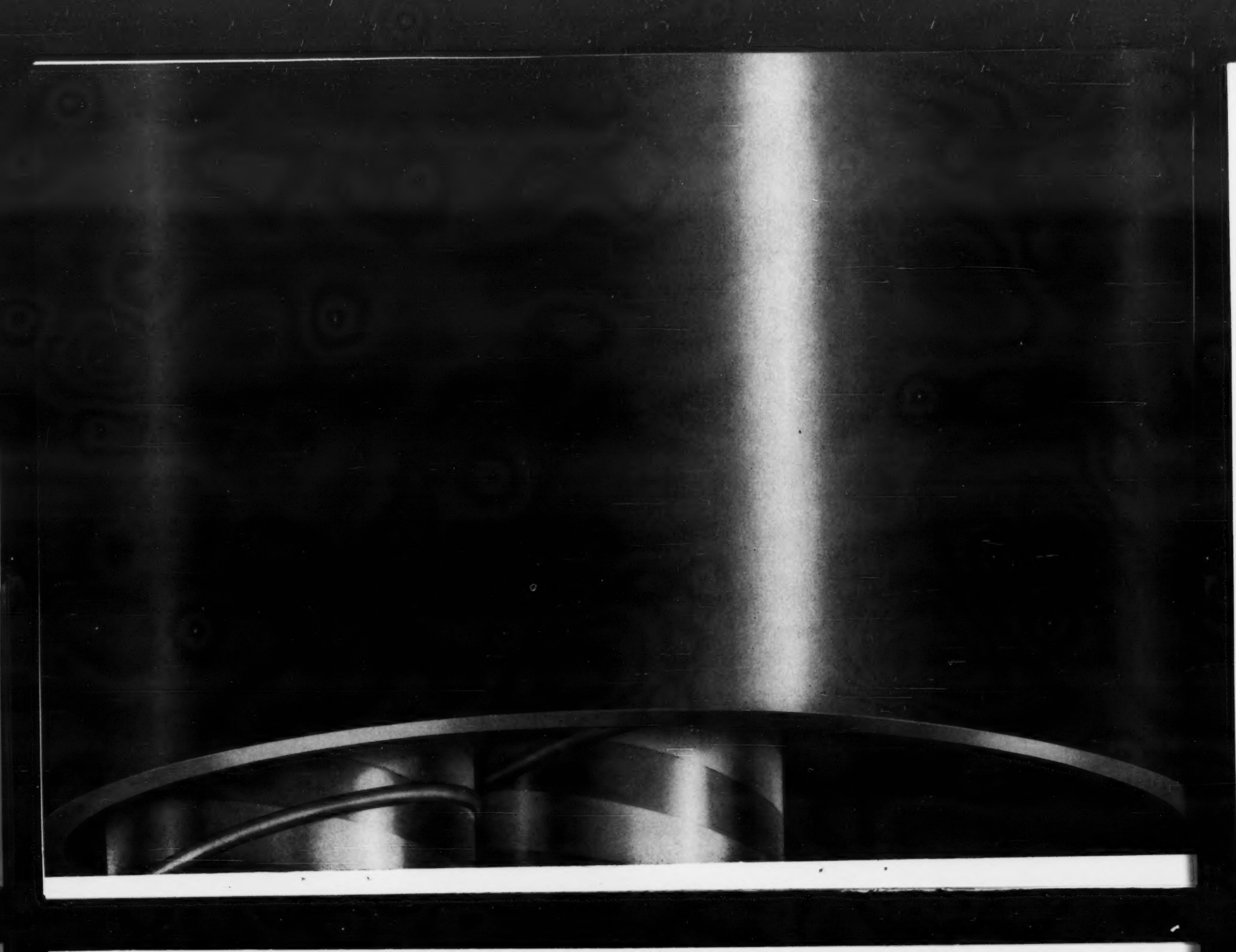
The free-cutting coppers may be machined at cutting speeds approaching those used for machining Free-Cutting Brass. For Tellurium Copper-127, however, carbide-tipped tools are recommended as the inherent copper telluride particles cause somewhat greater tool wear.

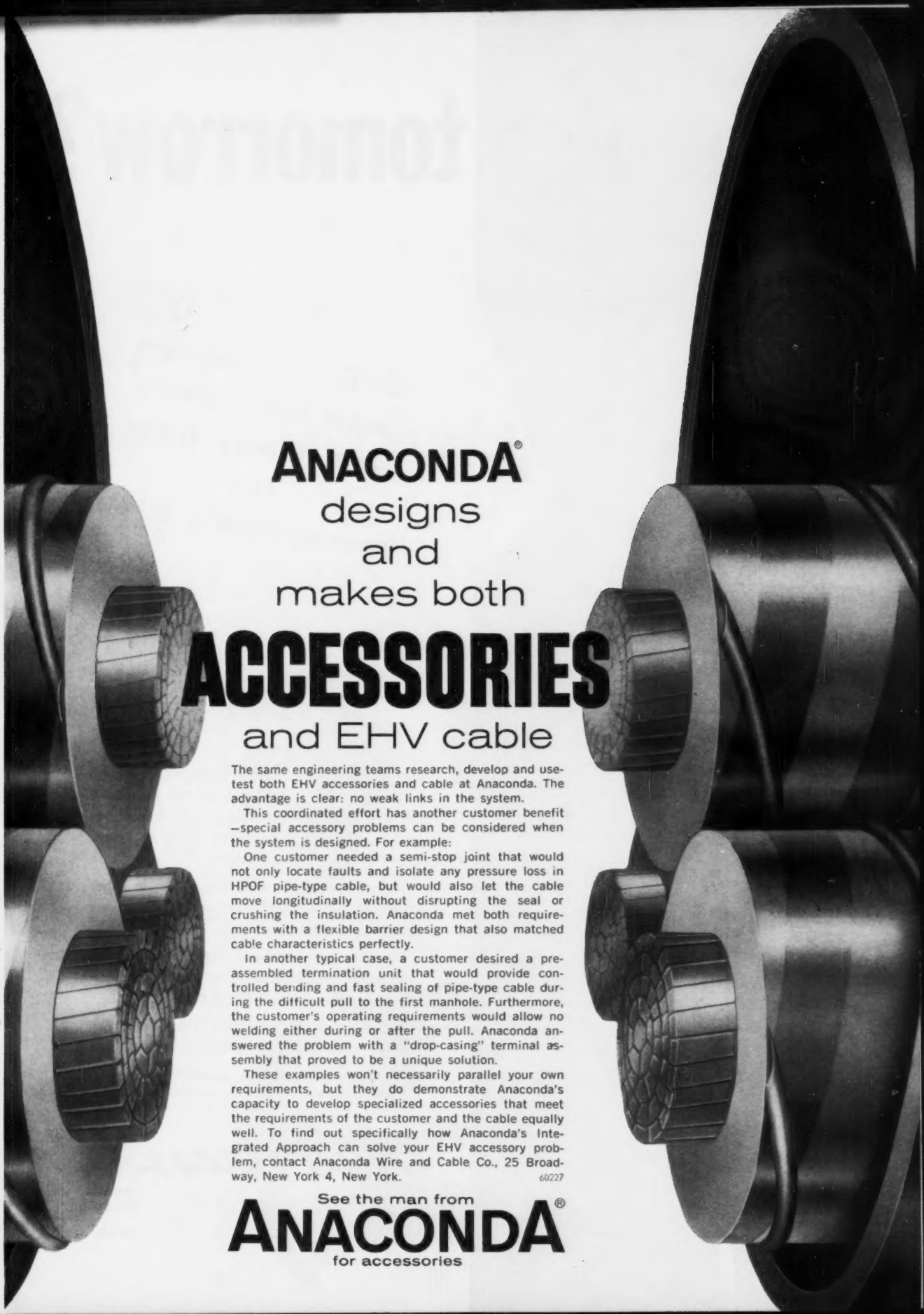
*Registered Trademark of American Metal Climax, Inc. 6047 Rev. L

ANACONDA®

FREE-CUTTING HIGH-CONDUCTIVITY COPPER PRODUCTS

Anaconda American Brass Company





ANACONDA®
designs
and
makes both
ACCESSORIES
and EHV cable

The same engineering teams research, develop and use-test both EHV accessories and cable at Anaconda. The advantage is clear: no weak links in the system.

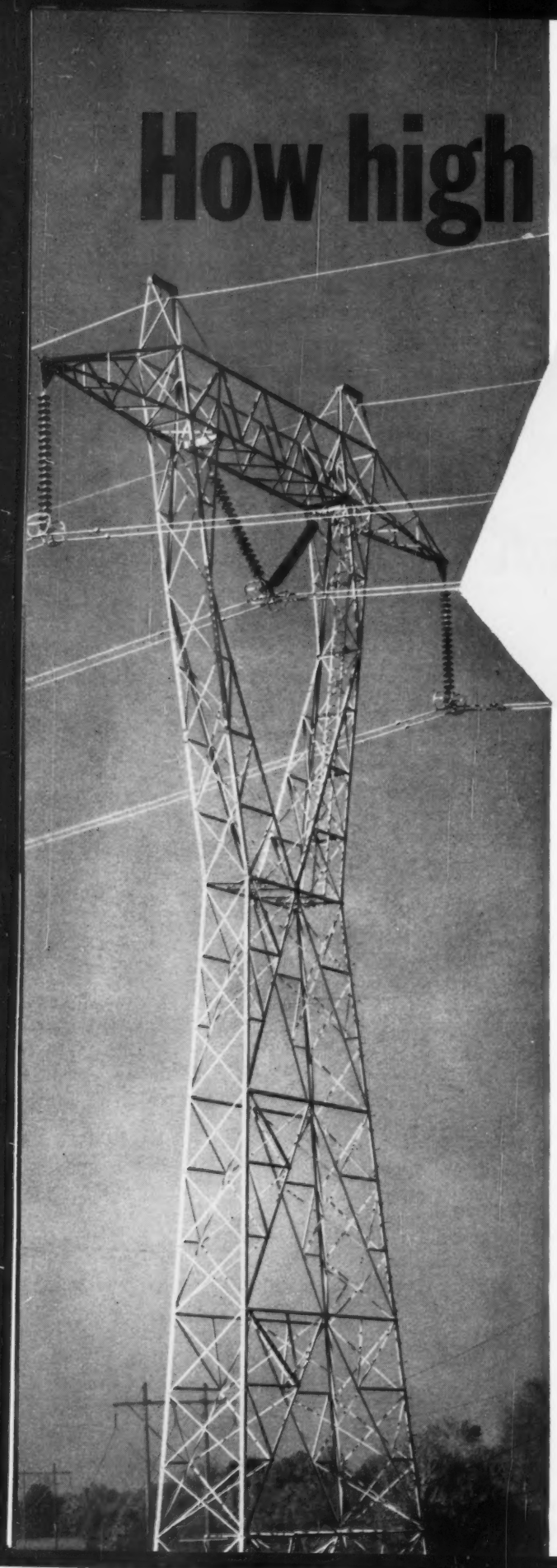
This coordinated effort has another customer benefit —special accessory problems can be considered when the system is designed. For example:

One customer needed a semi-stop joint that would not only locate faults and isolate any pressure loss in HPOF pipe-type cable, but would also let the cable move longitudinally without disrupting the seal or crushing the insulation. Anaconda met both requirements with a flexible barrier design that also matched cable characteristics perfectly.

In another typical case, a customer desired a preassembled termination unit that would provide controlled bending and fast sealing of pipe-type cable during the difficult pull to the first manhole. Furthermore, the customer's operating requirements would allow no welding either during or after the pull. Anaconda answered the problem with a "drop-casing" terminal assembly that proved to be a unique solution.

These examples won't necessarily parallel your own requirements, but they do demonstrate Anaconda's capacity to develop specialized accessories that meet the requirements of the customer and the cable equally well. To find out specifically how Anaconda's Integrated Approach can solve your EHV accessory problem, contact Anaconda Wire and Cable Co., 25 Broadway, New York 4, New York. 60227

See the man from
ANACONDA®
for accessories



How high tomorrow?

O-B insulators and hardware are ready now for tomorrow's EHV

Our broad experience on EHV test lines, on EHV operating lines, and on our own EHV research programs indicates that O-B insulator and hardware designs need place no upper limit on transmission voltages.

The designs you'll need tomorrow, in other words, are quite possibly the same O-B designs you're using right now!

No other insulator and hardware manufacturer offers greater breadth or depth of experience with Extra-High Voltage transmission.

No other offers the "look-ahead" benefits you get today in O-B insulators and hardware!

OHIO BRASS COMPANY, MANSFIELD, OHIO
Canadian Ohio Brass Co. Ltd., Niagara Falls, Ont.

Ohio Brass (B) HOLAN

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

10026-H

EH G g JK TJ TJK eh K F jk LM NF tef
NE NM TEF KL TKL LM EH TJ jkl EH k
K EH G JK TJK JK TEF NF Mm TKL eh
F JK LM NF Mm tef EH JKL G eh JK TJ
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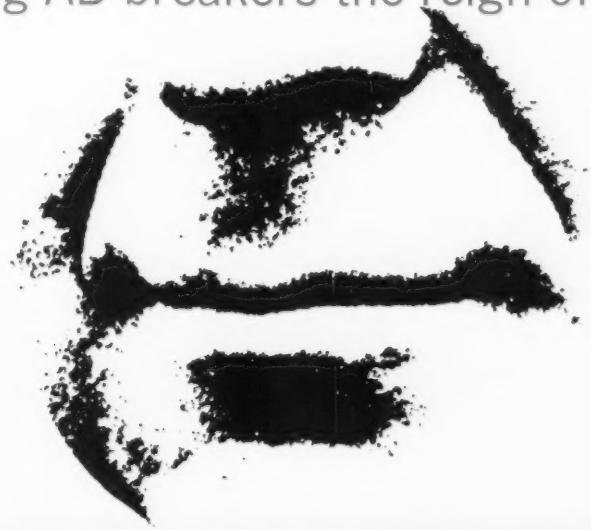
TJK JKL TJ G jk TKL NJ KL JK EH tjk

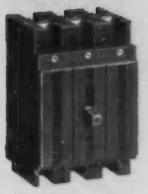
in specifying AB breakers the reign of confusion is over



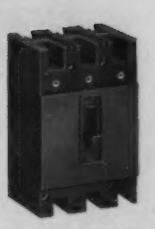
Westinghouse completely redesigns its breaker line

SIMPLE TO SPECIFY / EASY TO IDENTIFY

Newly designed breaker line simplifies frame designations . . . reduces space requirement up to 50%. Because of recent Westinghouse engineering advances, these new breakers retain the same high interrupting capacities of older designs in smaller frame sizes. The new designs mean it's easier for you to order, install and use AB breakers. Gone is the confusing assortment of letters that designate other models. These new breakers are easy to identify because they follow a common-sense sequence. They're simple to specify because you choose from only six breakers for virtually every application. They're better to use because they're smaller . . . yet you have the same quality and reliability of the former Westinghouse models you've been using.



E 15-100 amps, 240 volts a-c,
125 volts d-c, 1, 2 and 3 poles
IR @ 240 volts a-c: 7500 amps



FA 15-100 amps, 600 volts a-c,
250 volts d-c, 2 and 3 poles
IR @ 240 volts a-c: 20,000 amps
Replaces: EH, F and G breakers
Check Westinghouse for availability of this newest breaker.

JA 70-225 amps, 600 volts a-c,
250 volts d-c, 2 and 3 poles
IR @ 240 volts a-c: 25,000 amps
Replaces: J breakers

KA 70-225 amps, 600 volts a-c,
250 volts d-c, 2 and 3 poles
IR @ 240 volts a-c: 30,000 amps
Interchangeable Trip
Replaces: JK and K breakers

LA 125-400 amps, 600 volts a-c,
250 volts d-c, 2 and 3 poles
IR @ 240 volts a-c: 50,000 amps
Interchangeable Trip
Replaces: KL and JKL breakers

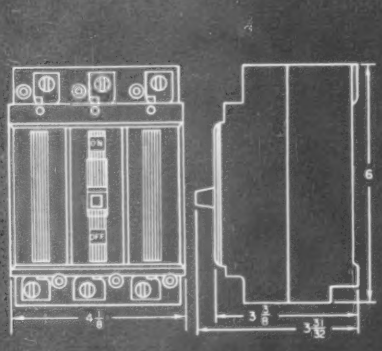
MA 125-800 amps, 600 volts a-c,
250 volts d-c, 2 and 3 poles
IR @ 240 volts a-c: 50,000 amps
Interchangeable Trip
Replaces: L, M and LM breakers

IR = Interrupting Rating

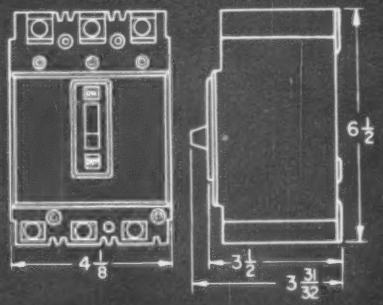
• Add the fact that terminals accept either copper or aluminum cable. Any way you look at it, the **NEW** Westinghouse line is the one you'll want to use from now on. • Want more information on this new line of breakers? Contact your Westinghouse representative, Westinghouse distributor, nearest independent panelboard-switchboard builder, or write Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. • We're offering a free wall chart that shows the new line of breakers. It measures 17 x 22 inches, is plastic coated and gives dimensions, interrupting ratings, maximum amps and volts and, of course, the newest designations along with the breaker photos. Write to the Westinghouse address above for your copy.

All Westinghouse AB breakers meet or exceed NEMA and UL specifications.

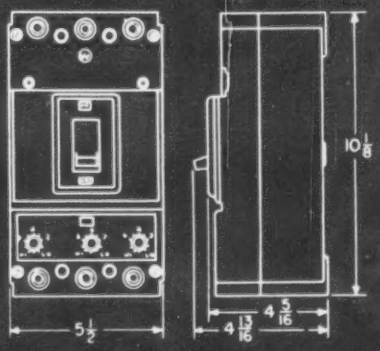
new breakers / new sizes / new designations



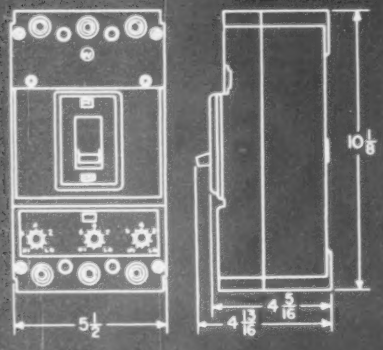
E 15-100 amps, 240 volts a-c.
IR @ 240 volts a-c: 7500 amps



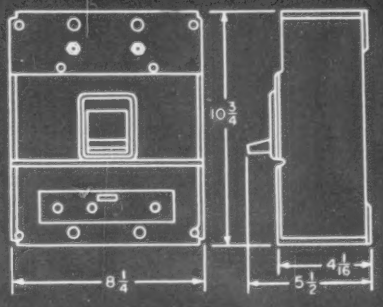
FA 15-100 amps, 600 volts a-c.
IR @ 240 volts a-c: 20,000 amps



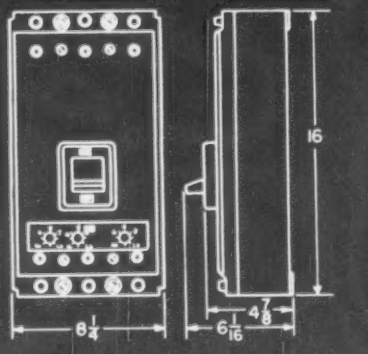
JA 70-225 amps, 600 volts a-c.
IR @ 240 volts a-c: 25,000 amps



KA 70-225 amps, 600 volts a-c.
IR @ 240 volts a-c: 30,000 amps



LA 125-400 amps, 600 volts a-c.
IR @ 240 volts a-c: 50,000 amps



MA 125-800 amps, 600 volts a-c.
IR @ 240 volts a-c: 50,000 amps

IR = Interrupting Rating

a Westinghouse breaker for every application

SAF-T-VUE* . . . lets you see whether the contacts are open or closed. Fills the needs of every industrial plant where safety codes require visible contacts. All frames.

MARK 75* . . . interrupts up to 75,000 amps at 240 volts a-c. Costs a fraction of conventional high interrupting capacity breakers. Does not require reactors or fuses, is particularly suited for network systems.

TRI-PAC* . . . smallest, lowest cost protective device you can apply where 100,000 amps can be poured into faults. Example: network systems or those fed by large transformers.

THERMAL MAGNETIC . . . provides instantaneous opening on short circuits, yet permits harmless momentary overloads such as those encountered in motor starting and initial lighting surges. On sustained overload, the higher the current, the shorter the opening time. All frames.

AMBIENT COMPENSATED . . . ends nuisance tripping, and eliminates need for derating where elevated or changing temperatures are encountered. All frames.

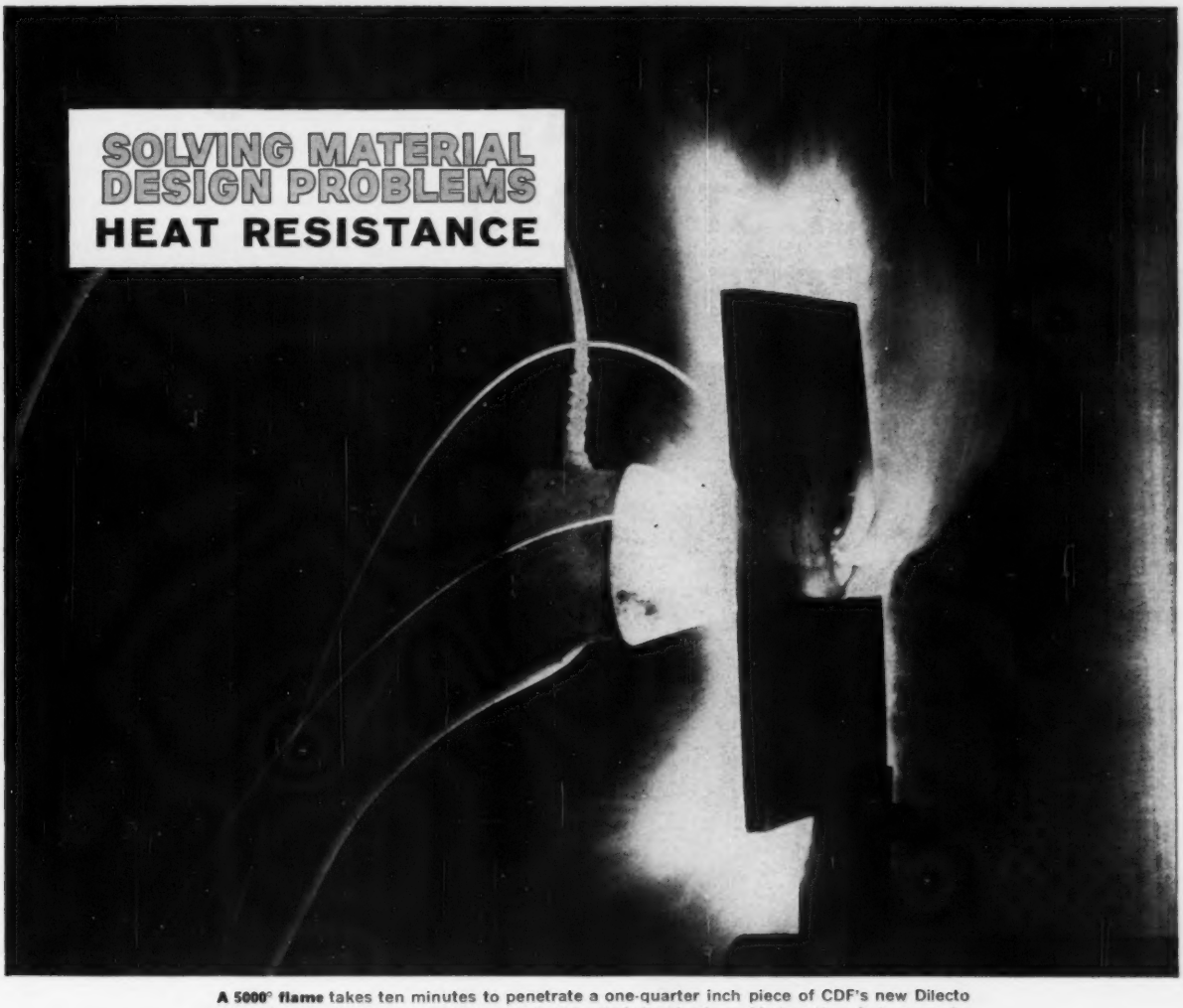
MAGNETIC ONLY . . . provides short circuit protection only. Primarily used on motor circuits where overload protection is provided by other means. All frame sizes except E.

WESTINGHOUSE ELECTRIC CORPORATION Standard Control Division, Beaver, Pa.

*Trade-Marks

Printed in U.S.A.

JI-30317



A 5000° flame takes ten minutes to penetrate a one-quarter inch piece of CDF's new Dilecto RD-105 laminate. The same thickness of cold-rolled steel is pierced in less than forty seconds.

Molded from graphite fabric impregnated with a heat (ablation)-resistant phenolic resin, new CDF grades RD-105 and RD-115 are being evaluated in solid propellant rocket motors.

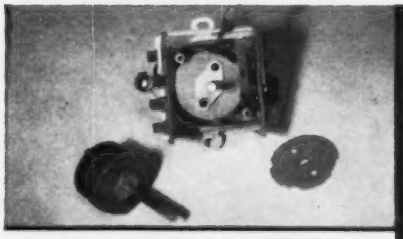
Dilecto laminates are only one family of products from industry's largest selection of non-metallic structural materials and electrical insulations. Vulcanized fibre, silicone rubber and mica, and thermosetting moldings are also supplied by CDF.

CDF can provide both quality and true economy in selecting plastic materials best suited to your needs. Refer to SWEETS PD file or write to us for General Folder 60.

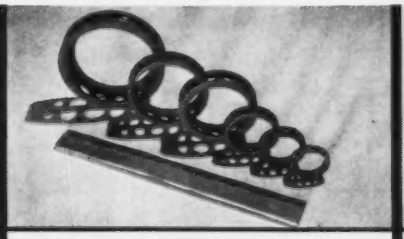
CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 86, DEL.

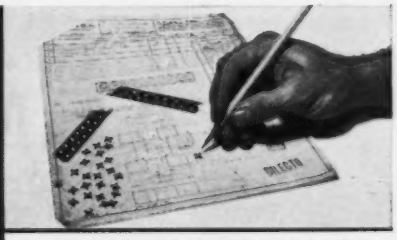
In Canada, 46 Hollinger Road, Toronto 16, Ont.



Moisture-resistant and low cost Dilecto cams for automatic washer and dryer controls.

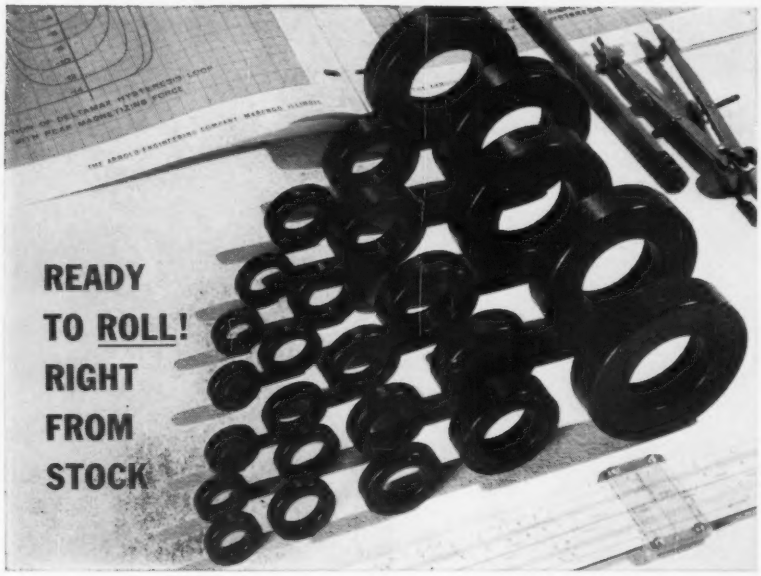


Dimensionally stable, light weight, oil-resistant Dilecto ball bearing retainer rings.



Easily fabricated paper-base, punching grade Dilecto precision switch insulators.

DESIGN WITH ARNOLD 6T CORES . . . SAME-DAY SHIPMENT OF STANDARD DELTAMAX CORE SIZES



Arnold 6T tape cores (aluminum-cased and hermetically-sealed) offer you three very important design advantages. One: Maximum compactness, comparable to or exceeding that previously offered only by plastic-cased cores. Two: Maximum built-in protection against environmental hazards. Three: Require no supplementary insulation prior to winding and can be vacuum impregnated after winding.

Now we've added a fourth vital advantage: Maximum availability. An initial stock of approximately 20,000 Deltamax 1, 2 and 4-mil tape cores in the proposed EIA standard sizes (See AIEE Publication No. 430) is ready on warehouse shelves for your convenience. From this revolving stock, you can get immediate shipment (the same day order is received) on cores in quantities from prototype lots to regular production requirements.

Use Arnold 6T cores in your designs for improved performance and reduced cost. They're guaranteed against 1000-volt breakdown . . . guaranteed to meet military test specifications for resistance to vibration and shock . . . guaranteed also to meet military specifications for operating temperatures. The 6T hermetic casing method is extra rigid to protect against strains.

Let us supply your requirements. Full data (Bulletin TC-101A and Supplements) on request. Check Arnold for all your requirements in tape cores, powder cores and permanent magnets.

1930A

ADDRESS DEPT. EL-10

ARNOLD

SPECIALISTS in MAGNETIC MATERIALS

THE ARNOLD ENGINEERING COMPANY, Main Office: MARENGO, ILL.
BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES.
Find them FAST in the YELLOW PAGES.

New & Improved Products

(Continued from page 8A)

Level-Wrap Tape . . .

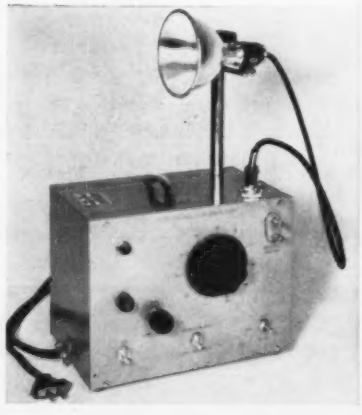
A new line of self-adhering, unsupported, silicone rubber insulating tapes features triangular cross sections that permit ready winding on irregular shapes. Each CDF Level-Wrap tape is as thick at its apex as the required total insulation thickness. When wrapped in overlapping halves, the tapes give smooth external surfaces. A colored center line guides the wrapping and overlapping. *Continental-Diamond Fibre Corp., Newark, Del.*

Hamband Receiver . . .

NC270 is a new double conversion receiver with 6-meter coverage that features a patented ferrite filter and an effective bi-filar T notch. In combination, these provide a degree of selectivity equal to the needs of the most ardent CW operator and side-band enthusiast, or to the toughest of AM signal conditions. *National Co., Inc., Malden, Mass.*

Electronic Stroboscope . . .

Designed for use in education, industry, research and the photographic field, the *E-30-Z* possesses an intensifier switch that increases the value of the firing capacitor causing the flash tube to emit double the amount of light.



This is particularly useful in photography. The flash tube and holder comes as a separate plug-in unit. Strobic range is from 250 to 2,500 flashes per minute, with the intensifier limited to 1,000 flashes per minute. *W. M. Bachman Associates, 2512 N. Shore Drive, Dept. EE, Clear Lake, Iowa.*

(Continued on page 24A)

LOWEST-COST TRANSMISSION LINE

Armless pole design eliminates crossarms, braces, hardware . . . saves up to one-third in material . . . more in labor of erection. Because insulator is stronger than crossarm, permits longer spans, larger conductors, greater safety margins. Requires narrowest ROW. Easiest-ever for hot-line work.

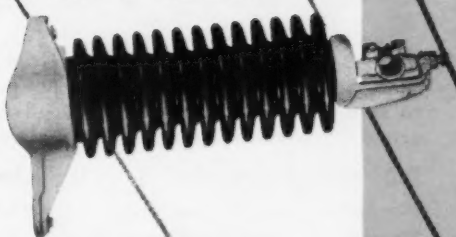
BEST-PERFORMING TRANSMISSION LINE

Horizontal mounting of Line Post encourages uniform wetting and self cleaning, improves wet flashover values by as much as 15% over upright ratings. Eliminates contamination flashover and pole-top burning.

BEST-LOOKING TRANSMISSION LINE

Neat, unobtrusive appearance avoids customer objection in urban and suburban residential construction. Can handle 69 kv, or higher, yet looks more like a "small" distribution line. Permanently free of RIV and TV interference, too.

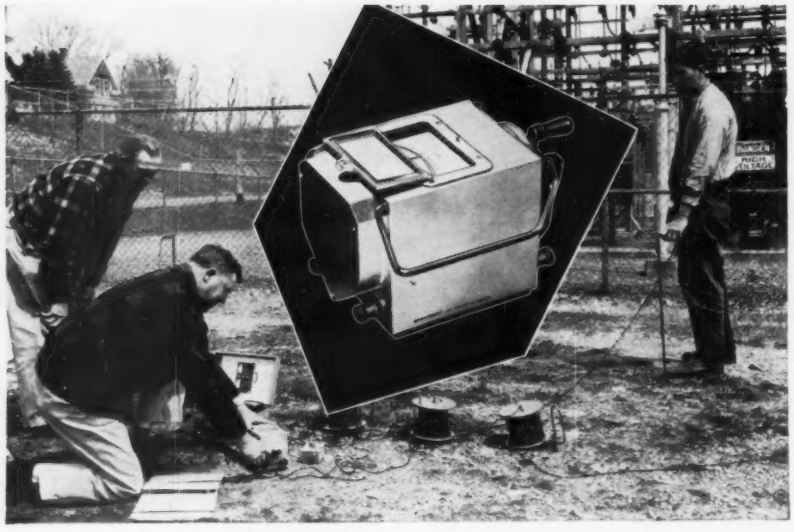
the insulator for armless transmission



Lapp Line Posts with clamp-top and integral-base-and-gain for horizontal mounting are available in voltage ratings of 35 kv, 45 kv, 55 kv, 66 kv and 88 kv. Each insulator is held by two through-bolts, and entire structure is easily assembled on the ground before erection.

Lapp

Modern armless construction with Lapp Line Posts is explained in detail in the new Lapp Catalog No. 8. Write for your copy.
Lapp Insulator Co., Inc., LeRoy, N. Y.

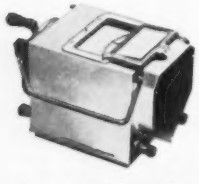


UTILITY PREVENTS ELECTROLYTIC CORROSION—RELIES ON MEGGER® GROUND TESTER

Worcester County Electric Company's underground cable system in central Massachusetts was the target of severe corrosion caused by low ground resistance to stray electrical currents, until laboratory tests revealed the situation.

After acting quickly to repair the corroded sections, the utility embarked immediately on a preventive maintenance program to stop further deterioration. The program was built around continuing tests with a Megger Ground Tester, selected because of the speed, ease and accuracy it provides in obtaining readings.

After a year's use, Worcester Electric finds that the Megger Ground Tester gives these advantages:



1 *It functions at all times*
2 *It does not have to be balanced*
3 *It does not require a power supply*
4 *It requires a minimum of maintenance*
5 *It takes rapid, accurate readings*

Savings attributed to the Megger Ground Tester preventive maintenance plan run into thousands of dollars per year. Worcester Electric is now able to spot areas of low resistance in their cables sufficiently in advance of actual breakdowns so that complete counteracting measures can be taken.

DO YOU HAVE THIS INFORMATION FILE ON GROUNDING?

The James G. Biddle Co. File 25 is an excellent fund of information on grounding problems. It includes a manual on Ground Resistance Testing, and bulletins on "Grounding Electrical Circuits Effectively" and "Grounding Principles and Practices Applied to Industrial Plants." B1018

Write Now for Your Copy of Ground Testing File EE

BIDDLE INSTRUMENTS

JAMES G. BIDDLE CO.

Electrical & Speed Measuring Instruments

1316 ARCH STREET • PHILADELPHIA 7, PA.

New & Improved Products

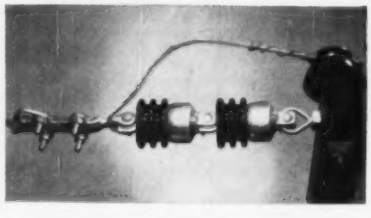
(Continued from page 22A)

Metalized Silicone Rubber . . .

This newly developed material is in search of a market and potential applications. Called Cohrlastic HG, it is composed of silicone rubber in which a high percentage of finely divided, heavy metal particles have been uniformly dispersed. Initial tests indicate a broad temperature range of from −85 to +500 F; extremely good resistance to weather, ozone, and ultraviolet light, unusually uniform shielding against X-rays, good electrical resistance properties of 10^{17} ohm-centimeter, a high specific gravity, and the advantage of being a resilient, flexible rubbery material. Send suggestions to: *The Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.*

New Insulator . . .

A new distribution deadend insulator that features all-aluminum hardware has a forged aluminum cap and stud that greatly increases its service life in corrosive atmospheres, and



makes the total weight 30% lighter than that of standard distribution insulators. A new porcelain shell contour also gives it a much higher impact strength and improves the appearance of distribution construction. *A. B. Chance Co., Centralia, Mo.*

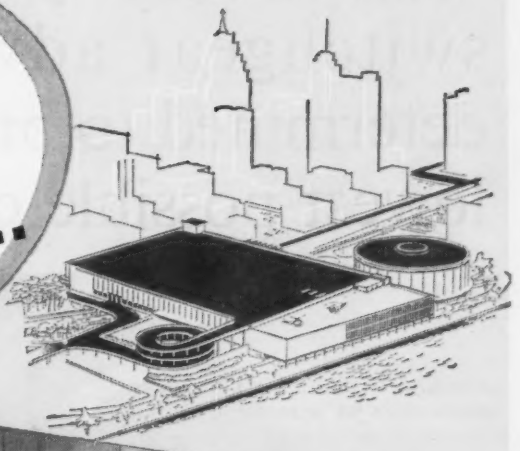
Maximum Meter . . .

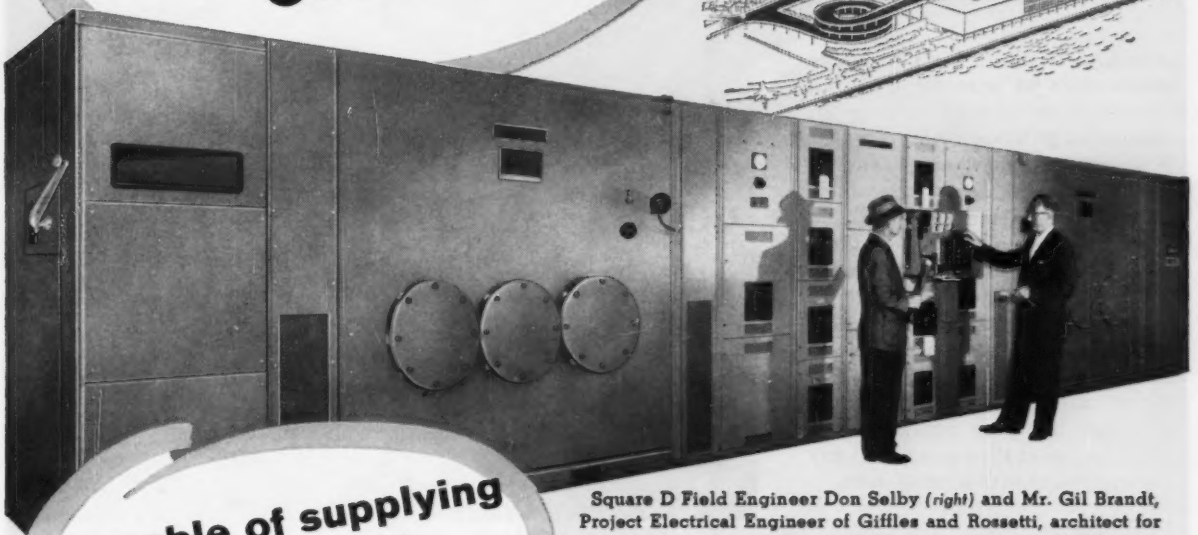
This instrument combines a meter-relay movement and special circuitry to show the highest level reached by an electric signal. Until reset, the adjustable pointer remains at the maximum signal over any period of time. The other pointer provides a continuous signal indication. Any variable that can be expressed as an electric signal can be measured. The instrument is available in standard sensitivity ranges of API panel meters and meter relays of 0-10 microamperes to 0-50 amperes; 0-5 millivolts to 0-500 volts, A-C or D-C. *Assembly Products Inc., Chesterland, Ohio.*

(Continued on page 30A)

11 SQUARE D SUBSTATIONS SERVE COBO HALL...

World's largest exhibition building, COBO HALL occupies 10 acres of Detroit's Civic Center





...capable of supplying 22,000 KVA of continuous power!

Square D Field Engineer Don Selby *(right)* and Mr. Gil Brandt, Project Electrical Engineer of Giffles and Rossetti, architect for COBO HALL, examining one of the drawout circuit breakers in the low voltage secondary portion of a Square D 2000 KVA double-ended unit substation equipped with nitrogen-filled transformers

Easy, fast installation was a prime objective when eleven Square D unit substations went into COBO HALL. The various sections of each substation were completely coordinated at the factory. Reconnection of those sections at the job site required a minimum of time and labor.

Design leadership is very much in evidence in Square D's broad line of unit substations. We suggest a three-point comparison to prove the point—ease of installation, minimum maintenance, maximum safety for both equipment and personnel.

AMONG OTHER SQUARE D EQUIPMENT IN COBO HALL

31 Control Centers
28 Switchboards
450 Panelboards
75 Contactor Panels
1 Dimmer Board
10 Dimmer Panels
16 NEMA 4-Circuit Interrupters
120 Spotlight Control Panels
19,000 feet of Lay-In Duct

SQUARE D COMPANY

wherever electricity is distributed and controlled

".....we knew you would want all these switchgear advances. And we were determined to bring them to you at the lowest possible cost."

—Frederick G. Schmidt, Manager Switchgear Division, I-T-E Circuit Breaker Company

Frankly, we had a big decision to make when we were designing this new HK metal-clad switchgear. Should we go ahead with a complete redesign or should we simply add the new features we knew you wanted to our previous models? The latter would have been easier, and it still would have put us well ahead of the field. But we decided it would be more honest to give you the benefit of as much progress as possible as soon as we could. And we were confident that in this case we could give you all these advances at a price no higher than you would pay for equipment with none of them.

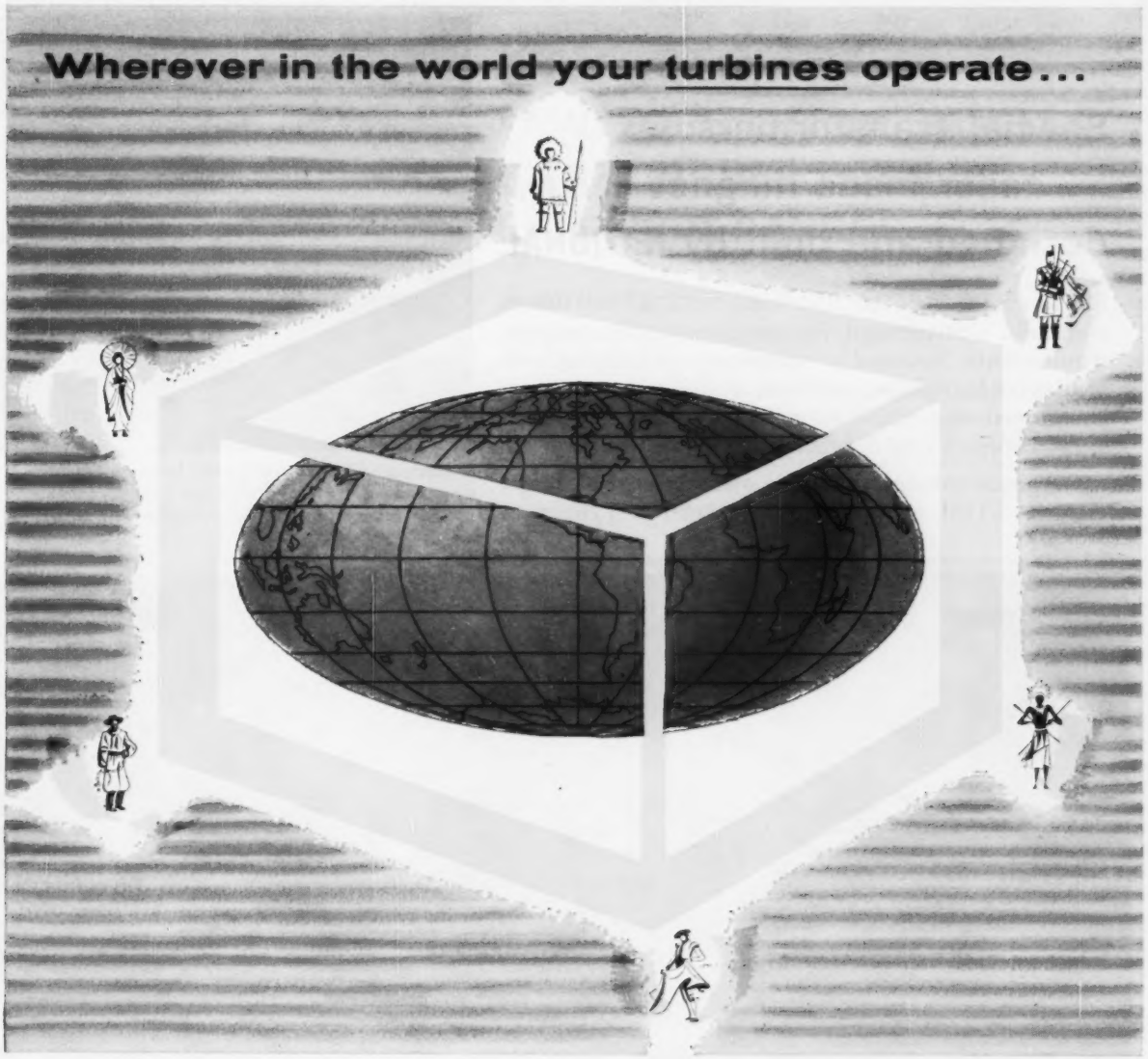
First we wanted to give you stored energy closing. No circuit breaker in this class can really be called modern today without this feature. It insures that you can have fast, uniform closing every time. In fact, I-T-E makes it possible for you to close the breaker even during emergencies when you have lost control power. Fast closing reduces breaker upkeep—prolongs contact life. And I-T-E's motor-driven spring charging mechanism needs only about one-tenth the power of other devices. So you can enjoy the economy of a smaller battery or control transformer.

To give you still greater safety too—again with no increase in cost—we designed this switchgear so you never need open the doors to move the breakers. You can go all the way from connected through test position, to disconnected, and back again with the door closed. Where else can you find safety like this in metal-clad switchgear? Even an inexperienced man can operate it in complete safety. Because we were designing this equipment completely new from the ground up, we had the opportunity to make the components more accessible and provided more elbow room inside the compartments. The bus is higher, for example, making installation and inspection easier. The control cables are brought in at the front for convenience and safe access away from the high-voltage bus. The current transformers are located behind the shutter in the circuit breaker compartment and may be easily changed without disassembling the bus or cable connections.

We were meticulous from the beginning about taking full advantage of the many new materials now available for switchgear use. And through careful selection of materials, skillful arrangement of components, and shrewd economy of space, we were able to give you all these advances in a substantially smaller package as standard equipment. The gear fits under lower overheads and in narrower aisles. Yet it gives you actually more usable space inside than you had before. Circuit breakers are lower, lighter and easier to handle. Instruments are at eye level. We believe you will agree there is no finer switchgear available today anywhere.

A complete description of this equipment is contained in our new illustrated Bulletin 2801-2A. Send for your copy. And ask to see our new sound strip film. We'll bring it to your office. You can see it in 18 minutes. I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Philadelphia 30, Pa.

Wherever in the world your turbines operate...



Shell Turbo Oil is there

Around the world, Shell Turbo Oil is available—under the same brand name and providing the same outstanding performance. This is assurance that your customers abroad will enjoy the superior turbine lubrication that domestic customers insist upon.

Shell Turbo® Oil provides these 4 outstanding reasons for its acceptance as a top-rated lubricant for utility, industrial and marine turbines: (1) It has exceptional oxidation stability for maximum service life. (2) It separates readily from water. (3) It protects against rust. (4) Its performance does not vary—make-up oil is identical to the original charge regardless of time of purchase.

No matter where your turbines operate, make Shell Turbo Oil your standard recommendation. Write for complete information.

Other outstanding Shell Industrial Lubricants available world-wide

Shell Tellus Oils—for hydraulic systems

Shell Alvania Grease—multi-purpose industrial grease

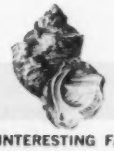
Shell Rimula Oils—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Dromus Oils—soluble cutting oils for high-production metalworking

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability



AN INTERESTING FACT!
Every Shell Branded Industrial Lubricant is named for a sea shell. Shown here is the Turbo crassus.

SHELL OIL COMPANY

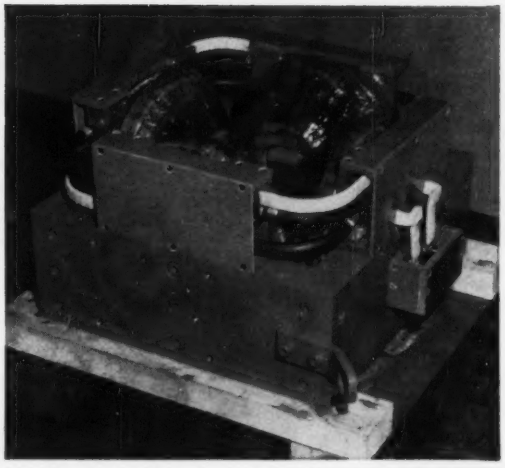
50 WEST 50TH STREET.....NEW YORK 20, N. Y.
100 BUSH STREET.....SAN FRANCISCO 6, CALIFORNIA
IN CANADA: SHELL OIL COMPANY OF CANADA, LIMITED
505 UNIVERSITY AVENUE.....TORONTO 2, ONTARIO

SHELL

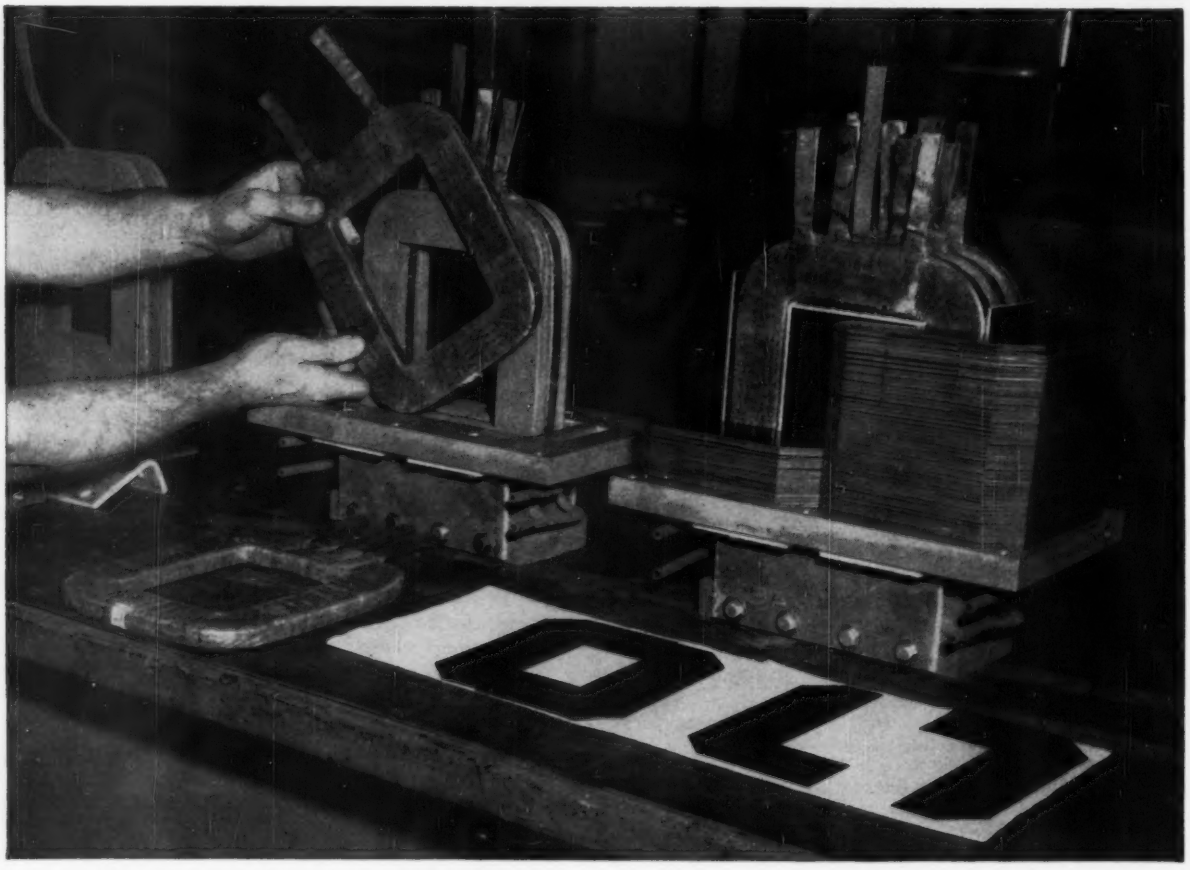
Special Transformers... tailor-made magnet coils... designed and built by NATIONAL

Starting with your specifications, National can design and build electromagnetic components for unusual requirements. National has experience in building coils of all types for rotating machines, as well as transformers and special magnets. National NECCOBOND insulation system opens a new approach to winding design.

For more information call our Columbus plant HUdson 8-1151, or the nearest National field engineer.



Quadripole for focusing proton beam in research apparatus. National coils are used in particle accelerators and other nuclear equipment.



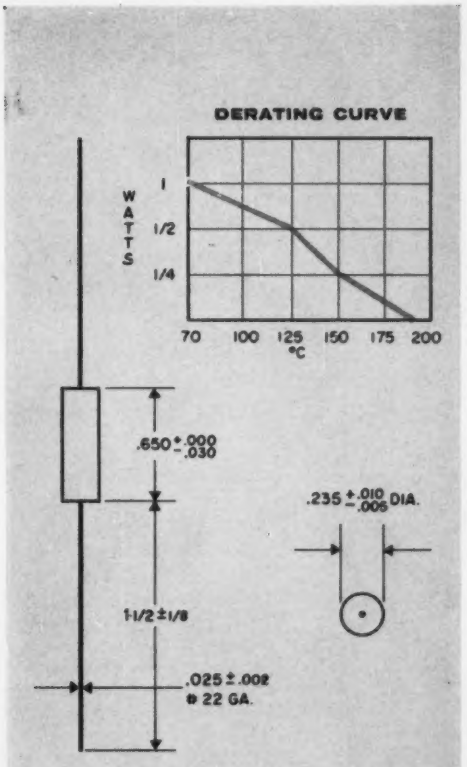
Special transformers deliver 4000 amperes at low voltage for heating glass-melting pots. National designed and built these water-cooled transformers providing intermediate taps for adjustment of primary voltage.

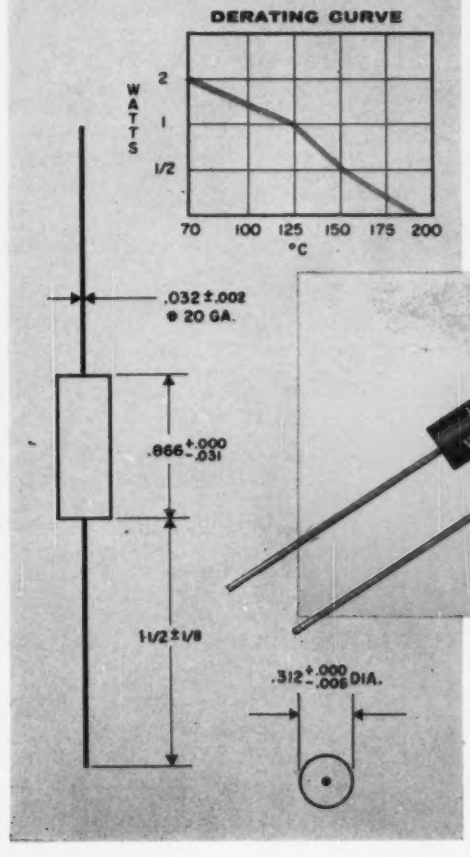
NATIONAL COILS

National Electric Coil

COLUMBUS 16, OHIO • IN CANADA: ST. JOHNS, QUEBEC

DIVISION OF McGRAW EDISON





ONLY WESTON VAMISTORS® OFFER SMALLER SIZES, HIGHER RATINGS, EXTENDED RANGES

1/4-watt and 1/2-watt size resistors give double ratings in ambients of 125° C

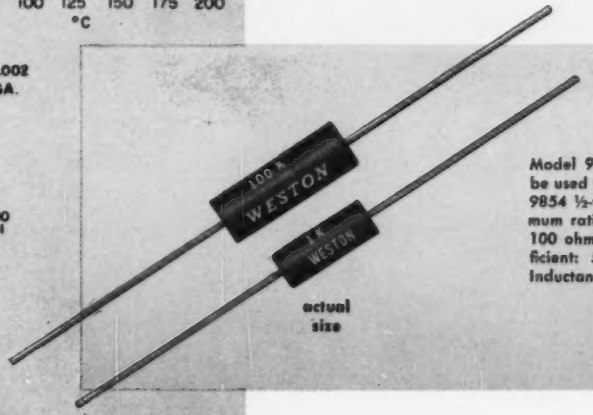
Miniaturized Weston VAMISTORS provide the desirable features of wire-wound and film-type resistors, yet offer higher wattages and superior thermal characteristics. For example, standard ¼-watt size "Missile Line" VAMISTORS are rated at half watt, and ½-watt sizes give a full watt at 125° C. Gas-filled "Missile Line" units thefore offer *twice* the wattage ratings of standard VAMISTORS!

Design advantages include high stability, low temperature coefficient, and tolerances of ±1%, ±.5%, ±.25%, and .1%. These new precision film resistors are virtually noise free, have extremely low inductances, and are available with resistances up to 5 megohms.

High reliability is assured, since Weston VAMISTORS are subjected to more rigid quality standards than *any other type* of resistor. They meet or surpass all applicable MIL specifications.

For special applications, pairs or sets of VAMISTORS can be matched to tolerances of ±.025% or temperature coefficients of ±5ppm of each other, or combinations of both tolerance and temperature coefficient.

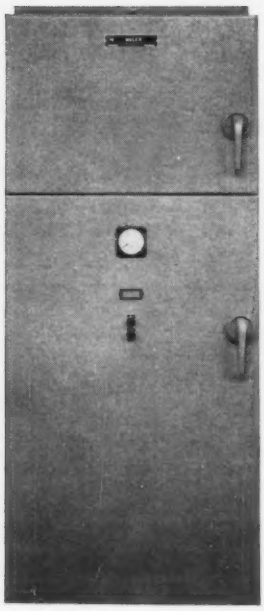
Call your Weston representative for full information, or write for Catalog 04-101. Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey.
International Sales Division, 100 Empire St., Newark 12, N. J.
In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.



Model 9855-4 ¼-watt size VAMISTORS can be used with a maximum of 350 volts. Model 9854 ½-watt size VAMISTORS have a maximum rating of 500 volts. Resistance ranges: 100 ohms to 5 megohms. Temperature coefficient: 50 and 25 parts per million/°C. Inductance: approximately .007 microhenry.

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION
Reliability by Design

102*



**102 — that's the number of Nelson high voltage starters* in use at just one of the many refineries using Nelson electrical control equipment.

This one refinery has been using Nelson starters for nine years.** What better evidence of complete satisfaction could be desired? Other industries such as paper mills, water and sewage pumping plants, and cement mills have also found that Nelson high voltage starters gave them the dependability and easy maintenance and installation so important to low cost operation.

This record of proven performance again confirms the fact that Nelson is

BIG ENOUGH TO PERFORM SMALL ENOUGH TO CARE

Be sure to let your Nelson representative figure your next job. You will find him listed in the Yellow Pages of major city telephone directories.

Write for your copy of the Nelson Pictorial Index.

*** Ask your Nelson man for the facts on this installation.*

NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA
P. O. BOX 5385 NAtional 7-5530

New & Improved Products

(Continued from page 24A)

Push-Button Timer . . .

A press of a button is all that is needed to start this new model *309* push-button timer. Available in 16 dial

ranges for a-c or d-c operation, the timer features automatic reset and shut-off. Other features include 0.0025 repeat accuracy, a metal-to-neoprene impingement clutch, and a SPDT snap action load contact in series with the motor, with an optional SPDT additional independent snap action contact if needed. *Automatic Timing & Controls, Inc., King of Prussia, Pa.*

Motor Protector . . .

A miniature circuit breaker, designed specifically to protect small motors in portable power tools and appliances, automatically cuts off power when the machine is overloaded or overworked. A reset button is used instead of fuses to reset the circuit breaker. *Modern Manufacturing Co., Inc., 680 Davisville Rd., Willow Grove, Pa.*

Fault Ferret . . .

This portable cable tester seeks out underground insulation failures before they happen by electronically breaking through the fault, and burning out the future failure to prevent "healing." High powered pulses of current are then fired into the fault so that its precise location may be traced and quickly repaired. Current leaking through the insulation is measured by the tester to indicate its condition. If the cable is faulty, the tracer generates a pulsed direction current over the conducting cable wiring. The current, returning by way of the cable sheath, is then divided at the precise point where the insulation break has allowed part of the tracer current to leak. *Sorenson & Co., South Norwalk, Conn.*

(Continued on page 50A)

NOMINAL WEIGHTS OF FINISHED WEATHER-RESISTANT WIRE AND CABLE

(Pounds per 1000 Feet)

Conductor Size AWG or Mcm	Copper & Copper Alloy Conductors				Aluminum Conductors	
	URC Type Double Braid	URC Type Triple Braid	Neoprene Type	**Polyethylene Type**	Neoprene Type	**Polyethylene Type**
Stranded						
2	246	270	248	**230**	105	**87.4**
4	155	170	163	**143**	73.3	**53.3**
6	103	115	108	**91.5**	51.5	**35.0**
Solid						
2	239	260	232	**219**	92.2	**79.2**
4	151	164	152	**136**	64.0	**48.0**
6	100	112	101	**87**	45.7	**31.7**

Sources: American Standards Association Specifications

This table shows

POLYETHYLENE covered line wire weighs less

Because it's the lightest, polyethylene-covered line wire is the easiest for linemen to string up . . . hardest for ice and snow loading, gale-force winds to bring down.

Polyethylene-covered line wire, depending on size and conductor, weighs from 5% to 32% less than other types. That's what the figures in the specifications tabulated above show.

This, of course, is no news to linemen who have strung all types of weatherproof line wire. They may not be able to quote pounds and percentages, but they all know you can't beat polyethylene on weight.

Linemen's Favorite Material

Light weight means easy handling, one of the main reasons polyethylene rates tops with installation crews. They also like polyethylene wire because it's clean . . . free-stripping . . . has a smooth, self-lubricating surface that almost makes pulling a pleasure. And despite the exterior slip, the plastic covering hugs the conductor tightly, doesn't ruffle as it goes over crossarms.

"Built-in" Safety Factor

Polyethylene's lightness provides lasting mechanical advantages, since span loads don't tax supports as much as heavier type wire. This "built-in" weight safety factor pays off when violent storms push aerial construction to strain limits . . . when ice and snow loads topple heavier lines.

An added factor in polyethylene wire's ability to stay up under adverse conditions is its smaller diameter. It offers less resistance to wind, a smaller surface for ice build-up.

Winning Combination

Called the "closest to the ideal covering for line wire," polyethylene is outstanding in other respects too. The shield it forms over wire is continuous . . . tough . . . resistant to aging, weathering, moisture, abrasion by lashing branches. It's good for decades of superior service marked by fewer outages, minimum maintenance.

When you order covered wire and cable, make sure the coating is made with PETROTHENE® polyethylene resins. PETROTHENE polyethylene costs no more, but it gives you premium weather and stress-crack resistance.

Polyethylene's advantages are outlined in an informative new U.S.I. data sheet, "Polyethylene . . . The Best Line Wire Covering." Also available is a data sheet showing properties, applications and specifications of PETROTHENE polyethylene compounds. Send for your copies today.

U. S. Industrial Chemicals Co.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.

Please send me:
☐ "Polyethylene . . . The Best Line Wire Covering"
☐ "PETROTHENE Resins for the Wire and Cable Industry"

Name:_____ Title:_____

Company:_____

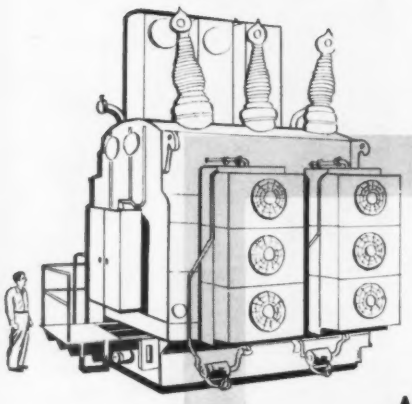
Address:_____

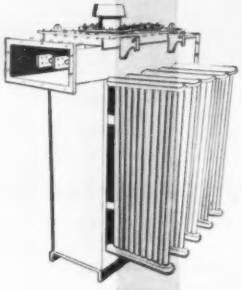
City:_____ State:_____

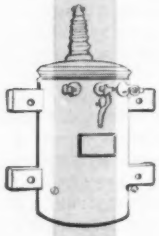
U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York, 16, N. Y.
Branches in principal cities

ARMCO STEELS / for electrical and electronic apparatus

New steels are born at Armco







Armco Oriented	Thickness mils	Cut Lengths	Coils	Max. Core Loss Test at 60[12], 15 kilogausses	Insulation
M-5	12	X	X	0.58	Mill anneal or CARLITE
M-6	12	X	X	0.64	
	14	X	X	0.66	
M-7	12	X	X	0.71	
	14	X	X	0.73	
M-8	14	X	X	0.80	

All Along the Line...

Armco's Oriented Electrical Steels Meet Specific Transformer Needs at Least Cost

From power plant to the last distribution transformer on the line, Armco's complete line of oriented electrical steel grades give you the advantages of a wide range of magnetic properties and excellent fabricating characteristics. In both design and production they enable you to improve performance and trim costs.

Besides offering an effective range of superior magnetic properties, Armco Oriented M-5, M-6, M-7, and M-8 facilitate manufacture of both stacked and wound cores. Good punchability and flatness not only speed shop operations but help assure as-designed performance. You also eliminate the trouble and expense of high temperature heat treatment because magnetic properties are fully developed at the mill.

Make full use of the opportunities created by Armco Oriented Electrical Steels. They can reduce size and cost and step up the efficiency of power, distribution and high performance transformers. Let us send you complete information. Armco Steel Corporation, 2850 Curtis Street, Middletown, Ohio.

Steel

ARMCO STEEL

ARMCO

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

ALLIS-CHALMERS

"Originators of 5/8% Step Regulators"

Caliband is an Allis-Chalmers trademark.

Lower! Lighter! Perfect for joint-pole use

new JFR regulators cut installation costs

CALIBAND control slashes setting time without changing customer voltage or interrupting service! A twist of the knob and you set or test voltage level and band width No need to return compensator settings to zero.

Allis-Chalmers all-new JFR is the top qualifier for joint-pole use . . . pad or platform mounting. Tank size and weight reduced up to 33%, due to JFR's improved materials and design techniques. Naturally, you save on transportation, handling and installation.

More new JFR advantages! Now offered as *standard*, position indicator drag hands reset by pushbutton on the control panel. A new, quick-sight gauge instantly reveals oil level. Exclusive unidirectional breather removes all moisture and contaminating gases. And a new cover, with hidden bushing mounting studs, cuts maintenance. *For all the facts ask your nearby A-C office for new JFR Bulletin 21B7977E or write* **Allis-Chalmers,** *Power Equipment Division, Milwaukee 1, Wisconsin.* A-1261

20 years beneath the sidewalks of New York

USS Tiger Brand Paper-Lead Cable

Like most utilities, Consolidated Edison of New York City, is engaged in an endless race to keep up with the growing demand for electric power.

In the Williamsburg section of Brooklyn, new USS Tiger Brand Paper-Lead Cables were installed to replace some of the existing ones that were being removed, due to system rearrangement, after 20 years or more of service. In some areas, the new cables were an addition rather than a replacement. The old cables were still giving good service but additional capacity was needed.

USS Tiger Brand paper-insulated, lead-sheath cables are noted for their reliability. More than 56,000 feet were used by Consolidated Edison in recent expansion programs. Engineering specifications called for 2/0, 27 KV, 3-conductor cable in carefully predetermined lengths for the Williamsburg section.

For high-voltage feeders, USS Tiger Brand Paper Insulated Cable is available in solid or gas-filled types. Many special constructions are available as standard production. An inquiry detailing your requirements will receive our prompt and careful attention. Write American Steel & Wire, 614 Superior Ave., N.W., Cleveland 13, Ohio.

USS and Tiger Brand are registered trademarks

USS Tiger Brand Electrical Wire & Cable —A standard cable for every special job

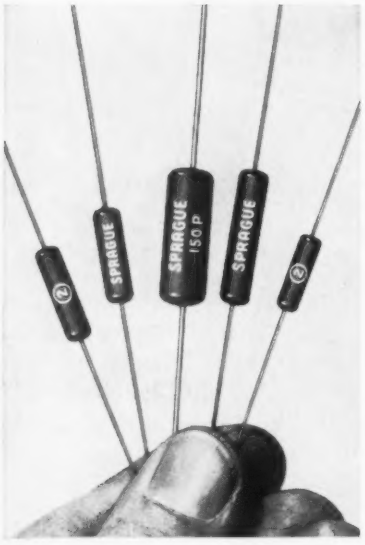
Asbestos Wire and Cable • Varnished Cambric Cable • Mold-Cured Portable Cord • Interlocked Armor Cable • Shovel & Dredge Cable • Special Purpose Wire & Cable • Paper & Lead Cable • Aerial, Underground and Submarine Cable

American Steel & Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

Power boost for Williamsburg area. Crew makes a 393-foot pull applying lubrication on the new Tiger Brand Cable as it is fed into the underground duct.

Miniature Dual-Dielectric Capacitors for 125 C Operation Without Derating



An improved version of Sprague Electric's famous Prokar® line of molded tubular paper capacitors has just been announced by the company as offering circuit designers small capacitors with improved humidity resistance for 125 C operation in military, commercial and industrial electronics.

Key to the improvement is the use of a new dual-dielectric which combines the dielectric strength of the highest grade capacitor tissue with the ion barrier effect of polyester film, giving these miniature units high insulation resistance plus extended life at 125 C. Type 150P Capacitors, as the new series is designated, are still impregnated with the exclusive high temperature organic material which marked a milestone in miniature molded capacitor development when Sprague first introduced it. The new series is designed for *operation at temperatures up to 125 C without voltage derating.*

For complete specifications on Type 150P Prokar 'D' Molded Capacitors, write for Bulletin 2300 to Technical Literature Section, Sprague Electric Company, 321 Marshall Street, North Adams, Mass.

Solid-Electrolyte Tantalex® Capacitors

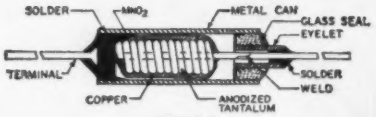


FIGURE A

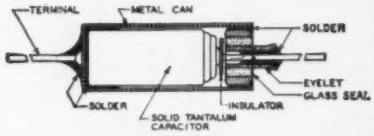


FIGURE B

The ultimate in reliability, achieved through constant research, is evident in Sprague Type 150D Solid-Electrolyte Tantalex Capacitors. True miniaturization and excellent stability of electrical characteristics make them ideal for transistor circuits in military and industrial applications.

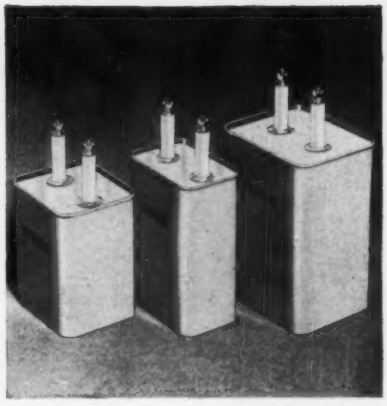
Figure A shows a typical construction used for low capacitance values. The anode is a coil of smooth-surfaced tantalum wire which has been anodized to obtain the dielectric surface film. This type of anode is used only for fractional capacitance values.

Figure B shows a typical porous-anode, hermetically-sealed capacitor. The anode is of the sintered tantalum pellet-type which exhibits a large gain in surface area per unit volume. Thus, the resulting capacitor has a large capacitance-to-volume ratio. It cannot leak or corrode even if the hermetic seal of the outer-metal case be broken or destroyed.

These capacitors may be used wherever stable capacitance and low dissipation factors are dictated over a wide temperature range. The capacitance varies by only a few per cent from room temperature down to −80°C or up to +85°C and the dissipation factor is nearly constant. These capacitors can be used at 125°C with proper voltage derating.

Write for Engineering Bulletin 3520C to Technical Literature Section, Sprague Electric Co., 321 Marshall St., North Adams, Mass.

New Dual-Dielectric Capacitors Surpass MIL-C-25A CP-70 Requirements



A new series of large drawn-rectangular case capacitors recently placed in production by the Sprague Electric Company surpasses MIL-C-25A Type CP-70 requirements for performance, reliability, size and maximum operating temperature without voltage derating. Sprague Type 272P Difilm Vitamin Q® Capacitors withstand the most severe operating conditions encountered in military and industrial electronic equipment. Unlike MIL-CP-70 units which require derating above 40 C and are limited to 85 C maximum, these new Sprague Capacitors can be operated at full voltage up to 125 C.

A duplex dielectric is used in these capacitors. It consists of both synthetic polyester film and the highest grade capacitor tissue. The impregnant is Vitamin Q, a synthetic polymer which has been used by Sprague with outstanding success in paper capacitors for many years. Seamless construction of the capacitor cases provides a virtually leakproof container with increased reliability over MIL-type units using fabricated cases.

The smaller size of Type 272P Difilm Vitamin Q Capacitor in comparison with that of oil-paper units for similar applications is important in many jam-packed equipment applications.

For complete engineering data, write for Engineering Bulletin 2340 to Technical Literature Section, Sprague Electric Company, 321 Marshall St., North Adams, Mass.

Institute Technical Groups

W. R. CLARK
MEMBER AIEE

It is the purpose of this article to give some of the past and present history of the major steps which have culminated in the recent decision of the Board of Directors to establish Institute Technical Groups and to discuss the Technical Group organization.

THE RECENT DECISION of the Board of Directors to establish Institute Technical Groups was first disclosed to the AIEE membership in a brief article by W. A. Lewis entitled "Formation of Proposed Institute Groups," which appears on pp. 386-87 of the May 1960 *Electrical Engineering*.

The first major steps toward the formation of Institute Technical Groups occurred back in about 1940 when Technical Groups, or Discussion Groups as they have sometimes been called, came into existence. They have proved to be a very successful part of the technical activities of many Sections. The attendance has been good at these group meetings, and the discussions have been invigorating.

Another important step occurred in 1948 when the Subcommittee on Electronic Instruments organized the first Special Technical Conference. Since then, numerous AIEE Technical Committees have organized Special Technical Conferences, each in its own field of technical interest. Since 1948, there has been an ever-increasing growth of interest in this activity. Today, the total yearly attendance at Special Technical Conferences exceeds the total attendance yearly at General Meetings, District Meetings, and Subsection Meetings. In fact, the total yearly attendance at Special Technical Conferences is rapidly approaching the total yearly attendance at Section meetings.

I feel that I have been very fortunate in having been associated with both these activities since their inception, and I have followed with great interest their growth and expansion.

In 1954, some of those members who were active in AIEE affairs began to realize that some changes were necessary in the AIEE organization to make it more attractive to the younger engineers. Numerous suggestions were received from AIEE members on this subject; and since this subject was of great interest to me, I was one of those making some suggestions. The Board of Directors on June 24, 1954, authorized the Committee on Planning and Coordination:

> "To conduct an over-all study of the present organization of the Institute, including its finances . . . made with a view to arriving at a more efficient and comprehensive plan of organization designed to operate within the available finances of the Institute and to provide for such subdivisions as may be needed for the efficient administration of the affairs of the Institute in the future. . . ."

Later the Planning and Coordination Committee was authorized to retain the services of Stevenson, Jordan and Harrison, Inc., management consultants, to assist them in this assignment.

THE STEVENSON, JORDAN AND HARRISON INVESTIGATION

AFTER a very thorough study of the situation, the Consultants made a very comprehensive report of their findings with recommendations to the Board of Directors. One of the main recommendations was the establishment of the AIEE department organization. It is described in *Electrical Engineering*, September 1956, pp. 857-59, and is the basis of our present organization.

Another recommendation was that AIEE expand the Technical Group activity in the Sections. The president, at that time, with the concurrence of the Board, appointed a committee under the chairmanship of J. C. Strasbourger to determine methods and means for implementing this recommendation. Mr. Strasbourger at that time was chairman of the Administration Department and quite familiar with Section operations.

As a result of the deliberations of this committee, two important actions were taken:

1. A survey of the membership of the Sections was undertaken to determine interest in the formation of new Technical Groups.
2. A Technical Operations Department (TOD) representative for each District was appointed to spark-plug technical activities in the Sections and to help tie in closer the activities of the Technical Committees of the Institute with the Technical Groups of the Sections. A TOD representative is a nonvoting member of TOD.

Since these two steps were taken late in 1956, 45 new Technical Groups were established in 64 Sections within the first 3 months. At present there are 260 Technical Groups in operation.

THE COOVER COMMITTEE

THE TOD FORUM at the 1957 Winter General Meeting was devoted to a complete review of the organization of Technical Groups in the Sections and of Technical Committees of the Institute. As a result of the talks presented and the discussion that followed, President M. S. Coover appointed an Ad Hoc Committee, with

W. R. Clark is with the Leeds & Northrup Company, Philadelphia, Pa.

The co-operation of I. S. Coggeshall, C. S. Rich, W. A. Lewis, and G. E. Herrmann in supplying the information given in this article is greatly appreciated.

W. R. Clark as chairman, to determine ways and means for providing a closer tie-in between the activities of the Technical Groups of the Sections and the Technical Committees of the Institute.

As a result of several meetings of that Committee, the following recommendations were submitted for consideration at the 1957 Summer Meeting of the Board of Directors:

1. The Section Technical Group Chairman, or his representative, should be appointed by the President as a liaison representative of the appropriate Institute Technical Committee.

2. Standardization of names of committees, subcommittees, and groups within Sections and Technical Committees is desired. It is recommended that, for a start, Technical Committee nomenclature be used insofar as possible.

3. The Section Technical Group Representative on the Institute Technical Committee should be identified in the Organization Manual with his Section affiliation.

4. The Section report forms, which are made out at the present time by the Technical Group representative in the Section, should be revised and amplified to include synopsis of Technical Group activities, including copies of papers presented (if available), and items of importance which would be of interest to other Sections or to the Institute Technical Committees. Copies of this report should be sent to: (a) the Chairman of the Technical Committee or the Division Chairman, if there is no appropriate Institute Technical Committee; (b) the TOD District Representative; (c) the Section Secretary, as at present; (d) District Vice-President; (e) Headquarters, as at present.

5. The Chairman of Institute Technical Committees should use this information in their reports for furthering the work of their committee.

6. Headquarters should correlate the information they receive, including minutes of Institute Technical Committee meetings as well as Technical Groups.

7. The resulting work should be published in appropriate form—items of general interest being edited and published in *Electrical Engineering*, possibly in a new section under the heading "Technical Activities."

8. The Headquarters Staff should be augmented to implement the above recommendations.

The Board voted that the report of the Ad Hoc Committee be received and referred to the Technical Operations Department, the Publications Department, and the Administration Department; and that their reviews and considerations be coordinated by the Planning and Coordination Committee, with a final recommendation brought to this Board and that the program be immediately activated to the extent that the Board authorize the TOD to request from the Sections the names of their respective chairmen of local Technical Groups, and further, to request that they furnish TOD with reports on the activities of local Technical Groups.

It was the consensus of the Board that the Ad Hoc Committee should continue its work.

Some of these recommendations have been achieved, i.e., the listing of TOD representatives in the Organization Manual and augmentation of the Headquarters Staff to assist in the operation of TOD activities.

Later on, this same committee made some additional recommendations at the February 7, 1958, Board Meeting which concluded their assignment. These recommendations were:

9. That the Board of Directors of the AIEE take immediate steps to compartmentalize the technical activities of the Institute so that the Institute be composed of Technical Divisions which are completely vertical within the Institute technical structure, extending from the top of the organization down into the Sections and Student Branches; thus, each AIEE member in addition to being a member of the Institute would become a member of one Technical Division. Each Technical Division should have its own publication.

10. The number of Technical Divisions at the start might be the same as those Divisions presently constituting the Technical Operations Department. Expansion of the number of Divisions may be desirable at a later date.

11. Each Section Technical Group would be assigned to the appropriate Technical Division.

12. Each member, upon payment of his dues, would receive *Electrical Engineering* (the form of this publication would not be changed by these recommendations) plus the publication of the Division of which he is a member. Membership in an additional Division would be obtained by the payment of additional dues, estimated to be approximately $3.

13. Each Division publication would contain:

a. The Transactions Papers of that Division.

b. Items of minutes of Technical Operations Department Meetings of interest to Division members.

c. Items from the minutes of Division Committee and Technical Committee Meetings of interest to Division members.

d. Items from local Technical Groups of interest to Division members.

e. Papers of interest presented by Technical Groups of the Sections assigned to that particular Division.

f. Proceedings of Special Technical Conferences.

g. Some of the Conference Papers presented at the General Meetings.

h. Some of the District Papers presented at District meetings.

i. Advertisements to help defray the expenses of the publications.

THE BARRETT TASK FORCE

In December 1957, President W. J. Barrett appointed a Special Task Force on Institute Activities and Organization to implement an action taken by the Board of Directors at the San Francisco meeting on June 28, 1956, which provided that a Special Task Force be appointed to study the various thoughts that were discussed by the Board at its meeting with the idea of

establishing some dynamic plan for implementing action to accomplish the objectives. W. A. Lewis was appointed Chairman.

Since the assignment of this newly appointed Task Force overlapped the assignment of the Coover Committee, and the Coover Committee had completed its investigation and reported its recommendations, it was discharged with thanks. In order to take advantage of the work already completed, the Chairman of the Coover Committee was made a member of the Barrett Task Force.

After consideration of numerous comments and suggestions from numerous sources and many meetings, the Task Force made the following recommendations, which are presented here in abbreviated form:

1. *New Activities Committee.* The Task Force recommends that the New Activities Committee recently authorized by the Technical Operations Department be fully implemented, to provide a separation between responsibility for operating an existing technical organization, and for establishing major modifications in the structures of the organization, to meet new needs. The Task Force believes that the responsibilities of operating existing Technical Committees, with established scopes, and maintaining a proper technical program are sufficiently demanding that these same committees should not be expected to be responsible for adapting the structure to meet all new changes and developments as they arise. By providing a separate committee whose primary responsibility is the consideration of proposed new activities and whose duty is to operate them for a limited time, until they are on an established basis, the Institute may be made much more flexible in meeting the demands of new technology, without sacrifice of the advantages built up in the existing organization.

It is, of course, to be understood that nothing in the preceding paragraph is intended to relieve the existing divisions and committees of the responsibility for continually revising their scopes and operations to meet changing needs. The New Activities Committee is intended to supplement and facilitate the process of continuous adaptation, and not to monopolize it.

2. *Institute Technical Groups.* The Task Force recommends that the Institute authorize the establishment of a series of Institute Technical Groups, each devoted to the activities of a Technical Committee, which exists now or may be created in the future. Such a group should be established in each area when the evidence of interest justifies the formation of the group. The same plan should be available in the areas of General Committees in other departments when appropriate.

The purpose of the proposed Institute Technical (or General) Groups is to provide for more direct participation of individual members of the Institute in activities now normally carried on by appointed committees.

3. *Publication.* If the proposed Institute Group activity is implemented, greater flexibility in publication policy will be needed to serve the membership of these groups adequately. It is proposed that the existing bimonthly publications be utilized to serve these needs, by making modifications as may be found most desirable. It is recommended initially that each Division be authorized to establish its own bimonthly type of publication—and, with increasing demand, it may be desirable to permit a single Technical Group to set up a separate publication. The Task Force recommends that control of publication policy on the bimonthly publications remain with the Publications Department, but subject to consideration of modified recommendation from the Technical Operations Department, based upon the operation of the Institute Groups.

4. *Cognate Memberships.* The Task Force recommends that the requirements for voting membership in the Institute be substantially broadened, to permit immediate entry into the Institute of professionally qualified engineers and scientists whose fields of education and past activity may have been in fields of endeavor different from Electrical Engineering as generally recognized, but whose current activities lie in or closely border upon Electrical Engineering, in its broadest aspects, and who have developed an interest in making contributions to an area of Electrical Engineering or Electrical Science.

5. *Directors to Represent Fields of Technical Activity.* The Task Force recommends specifically that the Directors of the Institute be allocated to Technical Divisions, so that two Directors represent, on the Board of Directors, technical backgrounds associated with each of the Technical Divisions.

The purpose of this recommendation is to provide broader technical experience on the Board of Directors, by insuring that the Directors are men whose combined technical experience covers all the major fields of Institute activity. This proposal corresponds, in the technical fields, to the manner in which the Vice-Presidents serve to provide geographical representation.

The Board at its October 1959 meeting approved in principle the first four recommendations but referred the last one to the Planning and Coordination Committee for further study with the Task Force.

This group after a careful review of the problem made the following recommendations:

1. That each Technical Division shall have the right and privilege of nominating a candidate for Vice-President in alternate years, to serve a 2-year term as a voting member of the Board. The Division shall select its candidate and submit his name to the Nominating Committee, in the same way that the District Executive Committee selects and submits its candidate for the office of District Vice-President.

2. That the number of Directors-at-Large shall be reduced from 12 to 8.

3. That each Department shall be responsible for proposing to the Institute Nominating Committee a candidate for Departmental Director to be designated "Director (General Administration, Publications, etc.)" and, as such, to serve a 2-year term as a voting member

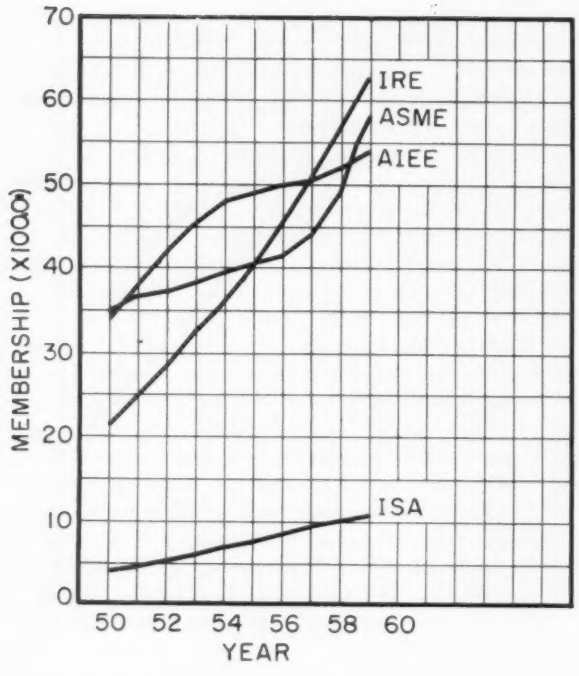


Fig. 1. Membership growth.

of the Board of Directors. The name proposed to the Nominating Committee by the Department shall be included in the slate of candidates for election by the membership in the usual way. The Departmental Director shall serve as Chairman of the Department.

4. That the Executive Committee of the Board of Directors shall consist of the President, as chairman, the Treasurer, and the Department Directors; also one Past-President, the Chairman of the Planning and Coordination Committee, the Chairman of the Finance Committee, and two other members of the Board as selected by the President.

The Board at its February 1960 meeting approved all four proposals and recommended that all eight recommendations be put in operation as soon as possible.

This gives a brief history of some of the steps leading to the proposed Institute Technical Groups, which is the main subject for discussion.

NEED FOR INSTITUTE TECHNICAL GROUPS

A look at some graphs will substantiate the feelings of the committees that some changes in our organization, or a change in emphasis on various activities of the Institute would be highly beneficial to the Institute's future.

The first graph to consider is that of membership growth (Fig. 1). For comparison, I have also plotted the growth graphs of some of our sister societies whose fields of interest overlap ours. The membership curves for the AIEE, IRE (Institute of Radio Engineers), and ISA (Instrument Society of America), do not include student members, but the figures available for ASME (American Society of Mechanical Engineers) for this period include students. We do know that ASME for 1959, not including students, had a membership of 46,804 compared to 58,421 including students. The AIEE rate of growth has been averaging about 3% per year. This year indications are it may be about 4%. The ASME growth for 1958 was 9.1%. The ISA growth has been averaging better than 7% per year for the past few years. The IRE growth has been averaging better than 10% per year for some time, and they have superseded AIEE as the largest electrical engineering society. (AIEE, however, has more voting members than IRE.)

What can AIEE do to increase its rate of growth? This question must be answered promptly and correctly.

A look at the statistics given in the AIEE Organization Manual will show, among other things, the changing interests of our members in various Institute activities. Of particular importance is the yearly attendance at various Institute activities. These figures have been plotted in Fig. 2. The attendance at Special Technical

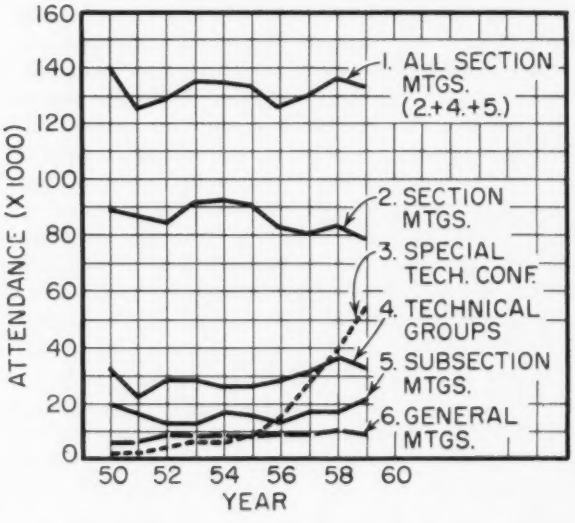


Fig. 2. Yearly attendance at Institute activities.

Conferences seems to be rapidly approaching the attendance at Section meetings. Attendance at Technical Group Meetings is also increasing as is also true of General Meetings. Attendance at main Section meetings is decreasing. This graph gives us some indication of the trend of interest of our members, but the curves of Fig. 3 tell a more vivid story.

A good criterion to use in determining the interest of our members in the various Institute activities is to compare the yearly variation of attendance at these activities with the yearly variation in Institute membership. To this end Fig. 3 shows the variation of the ratio of attendance at Institute Activities to Institute membership.

For satisfactory performance, the attendance at each

Institute activity should increase at least in the same proportion as our membership increases. This means that each line should be parallel to the abscissa or have an upward trend through the years.

However, the graphs show some alarming trends in the ratio, which I call the interest factor, during the past 10 years:

1. A 40% reduction has occurred in interest in all Section-sponsored meetings (Curve 1, Fig. 3).
2. This 40% variation is due almost entirely to less interest in the main monthly meetings of the Sections (Curve 2, Fig. 3).
3. The interest in Technical Groups of the Sections has remained practically constant since the high level of 1950 (Curve 4, Fig. 3).
4. The interest in Subsection Meetings has remained practically constant since the year 1952 (Curve 5, Fig. 3).
5. The interest in General Meetings has remained quite constant during the past 10 years (Curve 6, Fig. 3).
6. The interest in Special Technical Conferences has grown almost tenfold during the past 10 years (Curve 3, Fig. 2). This activity, therefore, has sustained our main interest growth and should be exploited.

Special Technical Conferences are, and have been, generated by the Technical Committees of the Institute. Sections, or the Technical Groups of the Sections, have been of incalculable aid in assisting in the manning of these conferences. These conferences were planned and still are planned to be a get-together of engineers having a common interest in a relatively narrow field of electrical engineering. All attending these conferences know the subject, have like interests, and can talk the same language. These conferences are, therefore, in essence a meeting of an Institute-wide Technical Group.

It seems very logical to combine the Special Technical Conferences, an activity which has a very good interest factor, with the Sections' Technical Groups, an activity which is maintaining its interest factor, and form Institute Technical Groups. This definitely would tie in the activities of the Technical Groups of the Sections with the Technical Committees of the Institute and should result in an activity having a high and ever-increasing interest factor. It should stimulate Institute growth.

FUNCTIONS AND DUTIES OF INSTITUTE TECHNICAL GROUPS

THE TASK FORCE had these thoughts in mind when they proposed the formation of Institute Groups. The function and duties of these Groups, as defined by the Task Force, would be:

1. An Institute Technical (or General) Group should be established in the field of any Technical Committee (or General Committee, if appropriate) upon evidence of adequate interest among the membership. For this purpose, the scopes of activities of the Committees should be publicized, and each member of the Institute should be offered the opportunity, through department auspices, to signify, by application, his interest in joining such a group, if formed. A group should be created whenever a specified minimum number of bona fide applications for membership in the group is received, and confirmed by the Technical Operations Department. The Task Force recommends initially that the minimum number of applications for the formation of a group should be 50.
2. Each group, as it is formed, should be assigned to the corresponding Committee, to operate and maintain. Individual memberships should be provided for all Institute members (only) who have made application, once the minimum number of applications, each accompanied by the initial dues, as specified below, has been accepted.
3. Each Technical (or General) Group should hold at least one business meeting yearly, at an AIEE General Meeting, at an appropriate Special Technical Conference, or at some District Meeting particularly suitable. This meeting should be a joint meeting with the members of the Committee and of the Institute Group, and should be organized by the Committee. At each meeting, the chairman, subcommittee chairman, and other committee members as necessary, should outline the plans for the activities of the Institute Group and Committee, report on work in progress and recently completed, subjects of proposed sessions, Special Technical Conferences and other meetings, standards activity in progress, and any other committee work of interest to the Group members. Members of the Group should be

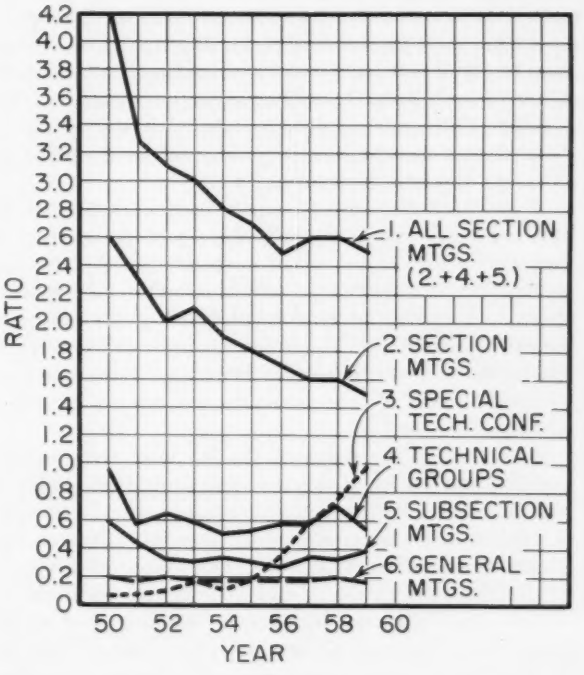


Fig. 3. Yearly variation of the ratio of attendance at Institute activities to Institute membership.

afforded opportunity to discuss all of the material presented, and to make suggestions for modifications or additions to the activity. Each year members of the Group should be given opportunity to suggest candidates for future membership on the corresponding Committee. It is entirely in order for members of the Group to volunteer for committee activity when they believe that they can be of service in the conduct of the activity program proposed for the Group.

4. Minutes of the Group meetings shall be kept, and copies of these minutes as well as copies of the minutes of other meetings of the Committee shall be distributed to all members of the Institute Group. These may be distributed separately, or possibly may be published in an Institute publication, as may be most suitable.

5. Notices of all appropriate Special Technical Conferences and other meetings of a District or Institute character in which the program is of interest to members of the Group should be distributed to each member.

6. Once an Institute Group has been organized, every effort should be expended to establish and enhance the prestige of the Group. Technical and professional activity should thereafter be attributed to the Group rather than to the Committee.

7. To cover the additional cost for such activities, the appropriate Department shall establish dues for each Institute Group formed, based upon the estimated costs of the special services provided for the members, and thereafter the corresponding Committee shall modify the Group dues, subject to Department approval, as may be needed to cover the additional costs encountered in the group operation.

8. Whenever an Institute Group is formed, a corresponding local Group may be established within a Section by the direct request to the corresponding Institute Group from a suitable number of Section members. The number of members recommended initially is 10. A local Group may be formed jointly by the members of adjacent Sections, if desired.

9. For each Institute Group formed, each Section of the Institute may have the privilege of designating a member of the Group, who is a member of the Section, as the Section liaison representative, with the responsibility of keeping the Section informed of the Institute Group activities. If a corresponding local Group is established within the Section, the liaison representative to the Institute Group should be selected by the local Group for its Section.

10. To serve the needs of the Institute Groups, the publications policy of the Institute should be modified and broadened to provide somewhat greater flexibility. To this end it was recommended that initially each Division be authorized to establish its own bimonthly type of publication which should include in addition to Transactions Papers, minutes or summaries of Committee and Institute Group Activities, proceedings of Special Technical Conferences, and under certain carefully controlled conditions, Conference Papers and District Papers that may be appropriate for publication.

ORGANIZATION

EACH Institute Technical Group would be authorized to establish its own bylaws which would have to be submitted to the Technical Operations Department for approval. The scope of Group activities must be clearly specified and be in accordance with the activities of the corresponding Technical (or General) Committee. Any change in bylaws or scope of operation must be approved by the Department. This Committee, in addition to preparing its present assignment, would also act as the Executive Committee for the Group and be responsible for the program and activities of the Group as a whole.

The officers of the Technical (or General) Committee should serve in the same capacity as officers of the corresponding Institute Group, except that upon the formation of an Institute Group, an additional officer, known as the Group Secretary, shall be appointed. Initially, the Chairman of the Committee would be appointed by the President, as at present, and he in turn should appoint the Vice-Chairman (one or two), the Committee Secretary, and the Group Secretary.

When membership reaches a prescribed number, which may be established from time to time by the Department, each Group would be offered the privilege, to be acted upon by vote, of electing its officers, in accordance with bylaws established by the Group, and these officers would then serve both as the Institute Group officers and the corresponding Committee officers. The Task Force recommended that the initial number required in order to establish election of officers should be 200 members. It should be a requirement that a candidate for Institute Group Chairman must have held one of the other offices of the Institute Group, and his term of office should preferably not exceed 2 years.

EXISTING TECHNICAL GROUPS IN SECTIONS

AN EXAMINATION of the existing Technical Groups of our Sections indicates that about 17 groupings of Section Technical Groups could be made which would have fields of interest comparable to a corresponding number of existing Technical or General Committees. About 55 Section Technical Groups would be included in the 17 groupings (see Appendix).

An additional five groupings of Section Technical Groups could be made which have a field of interest comparable to a corresponding number of our Technical Divisions. About 57 additional Section Technical Groups would be included in these groupings.

The remaining groups would involve two or more Divisions and some modification of their structure might be in order.

From this brief examination of the existing Group situation, it appears as if it would not be too difficult to establish Institute Groups based on existing Technical Groups of the Sections.

PUBLICATIONS AND FINANCING

THE FINANCING of Institute Technical Groups is one of the most important and one of the most difficult

phases of the entire program. I feel that establishing a good publication will do more to tie together the operations of Technical Groups, coordinate their activities, and promote their development than any other single action that could be taken. However, publications are expensive unless the quantities approach 5,000 per issue.

Let us look at the interesting figures given in Table I, which shows the number of Transactions Papers processed during fiscal year 1959-60 for each of our present existing Divisions. The Table also shows the estimated costs if the papers had been published in Division publications.

Table I. Transactions Papers for 1959-60 Fiscal Year

Division	No. of Papers	No. of Pages	Probable Editions	No. of Issues	Cost	Cost Per Edition
1. Communications	68	386	2,740	6	$17,026	$6.22
2. Instrumentation	15	82	1,820	1	3,474	1.90
3. Science & Electronics	106	656	5,507	6	28,610	5.20
A. *Publication* (1+2+3): Communication & Electronics	189	1,124	10,067	6	59,543	5.95
B. *Publication* (4+5):						
4. General Applications	34	210	1,586	2	8,816	5.56
5. Industry Applications & Industry	55	322	3,981	6	14,925	3.75
	89	532	5,567	6	30,143	5.42
6. Power	247	1,864	8,383	6	87,906	10.50
C. *Publication* (6): Power Apparatus & Systems	247	1,864	8,383	6	87,906	10.50
Totals for all Divisions	525	3,520	24,017		$177,592	$7.40

The probable editions' figures for Divisions were estimated, using the 1956 survey, which was made to determine the primary and secondary interests of our members. The probable editions' figures for each Publication (A, B, and C) are actual for the 1959-60 Fiscal Year.

The number of issues was estimated by placing a minimum of about 12 papers per issue.

The costs per edition for each Publication (A, B, and C) are actual, but are estimates on the Division basis.

It is obvious from Table I that the Bimonthlies, as they are now constituted, have a better balance of papers than would be true if we had Division Bimonthlies. Four of the Divisions at present could support a Bimonthly; the other two would need more papers.

It is also quite obvious that individual Group publications are going to be costly unless Group membership is in the thousands.

The cost per edition, which would be the annual cost per member, is high for the Power Division because of the large number of papers and large number of pages per paper.

If we arrange our Divisions so that each Division publication would total about 110 papers per year (735 pages), including Transactions Papers, proceedings of Special Technical Conferences, some of the better District Papers and Conference Papers, and some significant news items concerning the activities of the Groups of the Division, it is estimated that for 5,000 editions of 6 issues each, each publication would cost about $33,700 (or $36,200 for a 7,000 edition). This is for an organization having six Divisions.

If advertising were used on the inside of the front and back covers of each publication, this should mean an income of about $3,000 per Bimonthly.

In past years the Institute has subsidized the Bimonthlies. If this procedure is followed to the same extent as in the past, it would mean a credit of about $12,000 per Bimonthly.

Hence, the cost to a Group member for this Division publication would be approximately $3.50 for a 5,000 edition and $3.00 for a 7,000 edition.

It should be recognized that there will be some expense in operating each individual Group (i.e., preparation of mailing lists, sending out notices of meetings, conferences, etc.). This might amount to about 50¢ per member per Group. Hence, the dues per Group member would average about $4.00 per Group per Division with an extra charge of about $1.00 for membership in each additional Group in the same Division.

An average of 10 Groups per Division would require a membership per Group of 500 for a 5,000 edition and a membership of 700 for a 7,000 edition.

It should be recognized that the figures given in this section, while based on actual publication costs, are only estimates, and a more complete study of the publication problem will be required before final publication costs and dues figures can be obtained.

CONCLUSION

IT APPEARS that the formation of Institute Technical Groups is a very desirable undertaking which should prove highly stimulating to the Institute. It will take time to get the Groups organized, but it should not be too difficult in view of the Technical Groups already in existence in the Sections. Some realignment of Section Groups will be required, and it might be desirable to do some realignment of the Divisions of TOD. Financing of Division publications looks entirely feasible with reasonable Group dues, but individual Group publications maintaining AIEE quality might be expensive.

Appendix

The Sections listed have Technical Groups which would be aligned with Technical Committees of Divisions. Those listed under the heading "General" have a scope of interest approximating that of the entire Division.

COMMUNICATIONS DIVISION

General

Alabama
Chicago
Connecticut
Kansas City
Los Angeles
Maryland
Miami
Michigan
Mississippi
Nebraska
New Orleans
New York
North Texas
Philadelphia
Toronto

GENERAL APPLICATIONS DIVISION

Aero-Space Transportation

Denver
Lima
Los Angeles
Maryland
North Texas
Philadelphia
Seattle

Domestic & Commercial Applications

South Bend

Land Transportation

New York

INDUSTRY DIVISION

General

Arizona, Arrowhead, Boston, Chicago, Columbus, Houston, Los Angeles, Michigan, Nebraska, New Orleans, North Texas, Oklahoma, Philadelphia, Portland, San Francisco, Seattle, Spokane, Vancouver, Victoria

Feedback Control

Lima, Seattle

Mining Industry

Florida West Coast

Production & Application of Light

New York (Illumination)

Industrial Control

Maryland (Automatic Control)

INSTRUMENTATION DIVISION

General

Boston, Cleveland, Philadelphia, Los Angeles

POWER DIVISION

General

Arrowhead, Boston, Canton, Cleveland, Denver, Jacksonville, Kansas City, Memphis, Milwaukee, Nebraska, North Carolina, Shreveport, Philadelphia, Spokane, Victoria, Worcester

Insulated Conductors

Worcester

Power Generation

Spokane (Nuclear)

Relays

Shreveport, Victoria, North Texas

Rotating Machinery

Dayton, Fort Wayne, Milwaukee

Transmission & Distribution

Victoria

SCIENCE AND ELECTRONICS DIVISION

General

Michigan, New Orleans, San Francisco

Basic Sciences

Boston, Chicago, Cleveland, Erie, Los Angeles, Milwaukee, New York, Seattle

Computing Devices

Arizona, Cleveland, Dayton, Erie, Philadelphia

Electronics

Chicago, Los Angeles, Milwaukee, Philadelphia, Spokane, Vancouver

Nucleonics

Boston

MANAGEMENT COMMITTEE

Boston, Cleveland, Columbus, Connecticut, Erie, Los Angeles, Maryland, Philadelphia, Seattle, Spokane, Washington

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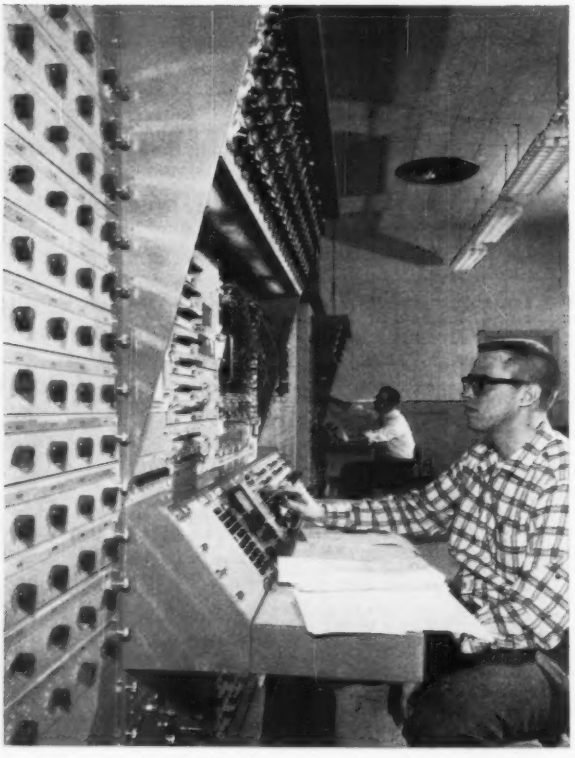
Precision Analog Computing Equipment



Precise evaluations in the production of the B-52G and new B-52H missile bombers, as well as in futuristic research and development projects, are currently being obtained at the Boeing Airplane Company's Wichita, Kans., Division through the use of Precision Analog Computing Equipment (PACE), two units of which are shown at the left.

Use at Boeing-Wichita of the PACE computers is now concentrated primarily on solving engineering problems in time history and parameter variation studies. Four model *231-R* PACE computers are employed in this effort. Heavy utilization of the equipment is being made in studies conducted in three primary areas: (1) landing loads analysis to determine what happens to an aircraft structurally under various landing conditions; (2) operation of the 120-kva mechanical drive and electric power system earmarked for the B-52H missile bomber; and (3) low-level flight investigations and aerodynamic stability studies designed to perfect an attack concept that would allow the new Strategic Air Command missile bombers to streak to potential enemy targets at extremely low altitudes.

The four model *231-R* PACE units used at the expanding Boeing-Wichita Analog Computer Laboratory have a total of 304 operational amplifiers, 510 coefficient potentiometers, and related multipliers, function generators, and resolvers.

Adventures in Energy Conversion

R. W. PORTER

A speculative survey is projected of the technological opportunities beckoning at the frontiers of knowledge in the realm of energy conversion. American industry is urged to venture its support, in spite of the considerable risks, for the rewards are substantial.

THIS is rightly called an adventurous age. The last great land mass of the world, Antarctica, is yielding to man's exploration. The depths of the oceans and the extremities of the atmosphere are being probed. Instruments are being designed for landings on the moon and nearby planets. The minds of scientists are pushing inward into the nucleus of the atom and outward to distant galaxies. As we explore, we learn. And as we learn, we have many opportunities to put this new knowledge to work for mankind through speculative—adventurous—technological developments here on earth.

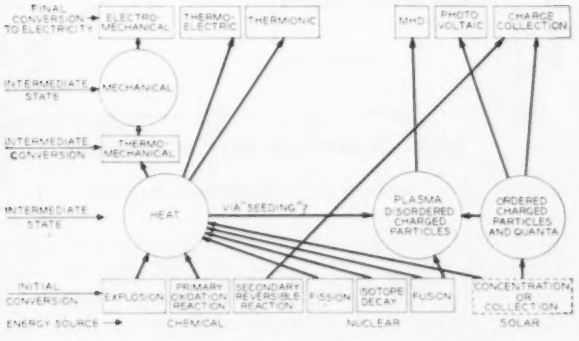


Fig. 1. Energy conversion terminating in electricity.

Among these speculative technological opportunities, some of the most interesting are those related to energy conversion, for the wresting of available energy in the form of electricity from the more primitive forms in which it has been stored away in the crust of the earth has long been a major challenge to the engineer. To date, the only economical large-scale method of obtaining electricity from the earth's crust has been to burn fossil fuels in a boiler and expand the resulting superheated steam through a turbine which rotates a powerful magnet inside some stationary coils of wire. (Fig. 1) Associated with this process is the inherent thermodynamic inefficiency of the steam cycle, a measure of which is the waste heat that must inevitably be discharged into the condenser. When this and other losses are taken into account, a modern steam turbogenerator system is limited to an over-all efficiency of about 39%. In other words, it requires about 8,700 Btu of fuel for each kw-hr of electricity produced.

We know of two ways to get around the thermodynamic limitation. One is to avoid it entirely by converting the stored chemical energy of the fuel directly into electric energy without the intermediate step of conversion into heat and mechanical energy (Fig. 1). The other is to increase the temperature at which the chemical energy is converted into heat of working fluid. Much progress has been made in the design of turbines and in improving the materials from which they are constructed, leading to operation at higher and yet higher temperatures. More progress can be expected. However, there are signs that this "vein" may be "petering out." The more adventurous utilities and electrical manufacturers are beginning to "prospect" in other technological areas that offer opportunities to bypass the thermodynamic limitation, to make a really significant increase in temperature, or at least to simplify the system by elimination of rotating machinery (Fig. 1).

What are some of these other areas that look promising, and what are the chances of finding "gold" therein?

FUEL CELL

ONE OF THESE AREAS, and from the thermodynamic point of view certainly the most attractive, is the fuel cell (Fig. 2). It is not a new idea; in fact it is more than 100 years old. When it was originally conceived, the basic sciences of thermodynamics and electrochem-

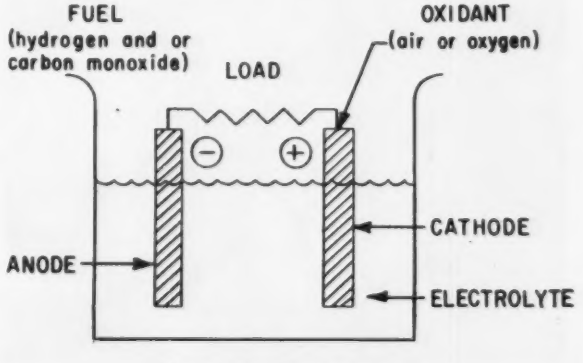


Fig. 2. Schematic of a fuel cell.

An article based on remarks made at a symposium on "Exploring the Future of Direct Energy Conversion," held during the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960.

R. W. Porter is with the General Electric Company, New York, N. Y.

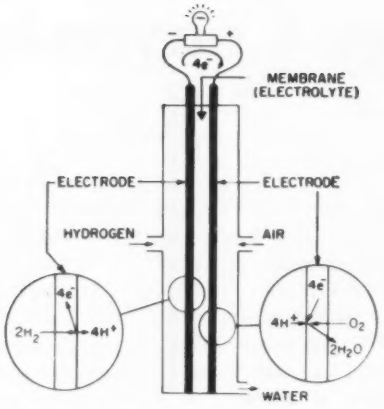


Fig. 3. Schematic of ion-membrane fuel cell.

istry were not yet strong enough to support the development of a practical device, and electrical engineering had not yet developed enough applications for electric energy to provide an adequate incentive. Later, in the first third of this century, the rapid development of the steam turbine and the internal combustion engine diverted attention from the fuel cell. Thus, it has only been during the past decade or two that scientists and engineers have returned to this old idea with renewed interest and determination to make it pay off. Many alternatives, having widely different temperatures and pressures, reactants, electrolytes and catalysts, electrode configurations, and so on, are now being worked on. Some names given to these alternative combinations are Hydrox—essentially any low- or intermediate-temperature hydrogen-burning cell; Redox—a more complicated cell in which the reduction and oxidation reactions take place on intermediary substances which are then passed over inert electrodes where they release or absorb electrons; Molten Salt—a high temperature cell using molten salt, such as alkali carbonates, as electrolyte; Carbox—a high-temperature carbon-oxygen system; and of course there are many others.

One type of cell that has been given considerable attention at the General Electric Company is the ion-exchange membrane hydrox cell. Most of our experience has been with acid ion membrane cells (Fig. 3), although basic ion cells are also feasible. Water is formed at the oxygen electrode as the end product of the electrochemical reaction, as can be seen in the photograph of a small demonstrator cell (Fig. 4). Inasmuch as this type of cell is rather compact and light in weight, operates at low temperature and pressure, and yet has reasonably high efficiency, it is suitable for military and other portable or mobile power supply applications, including those for certain types of space vehicles. Current density as high as 40 to 50 amperes per square foot of membrane can be obtained, and the power density can approach 25 watts per square foot (Fig. 5). The specific fuel consumption varies from less than 0.08 pound of hydrogen per kw-hr at very light loads, to about 0.15 pound per kw-hr at maximum power density (Fig. 6). These extremes are equivalent to about 4,900 Btu per kw-hr or 74% efficiency and 9,200 Btu per kw-hr or 39% efficiency, respectively. The tendency for efficiency to be highest at light load and to drop off with increasing load is characteristic of fuel cells generally, although it varies considerably from one type of cell to another.

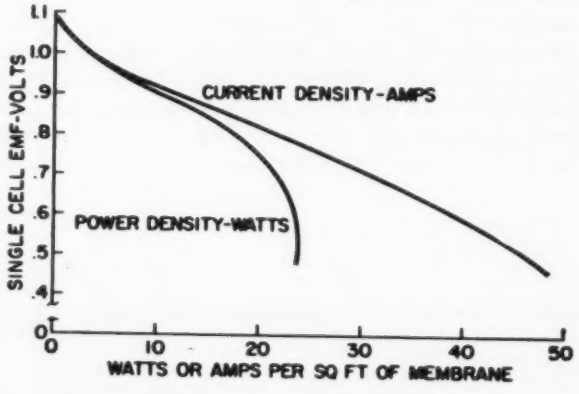


Fig. 5. Performance of ion-membrane fuel cell.

Fig. 4. Ion-membrane fuel cell.

A quick survey of the present and the projected state of the art (Fig. 7) indicates that such a cell might have a basic cost as low as $210 per kw-hr. An alkaline hydrox cell, which would avoid the use of platinoid catalyst material could conceivably bring this cost down; we project a basic cost as low as $42 per kw-hr.

On the other hand, a molten carbonate cell which could "burn" less expensive fuel at very high efficiency might eventually have a cost on the order of $150 per kw-hr.

There is a long way yet to go. The ion exchange membranes are expensive and difficult to manufacture and handle. Less costly catalysts must be found. Operating life must be extended—and this leads to some very challenging materials problems, especially with respect to the high-temperature cells. Full load efficiency needs to be improved. Control problems must be investigated for various applications. And, of course, designs must be worked out for easy, low-cost maintenance.

THERMOELECTRIC CONVERSION

ALMOST AS OLD AN IDEA as the fuel cell is the thermoelectric converter, based on an effect first noted by Thomas Seebeck in 1821. Because of its poor efficiency

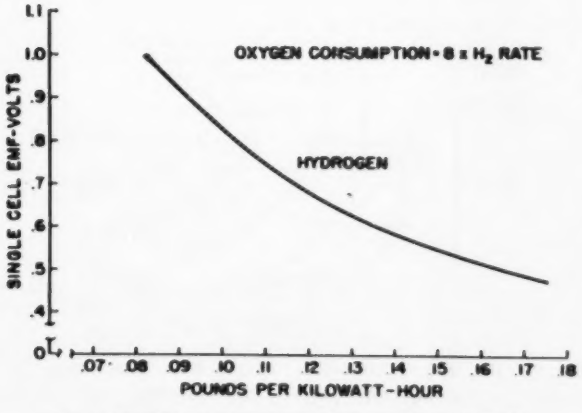


Fig. 6. Specific fuel consumption of ion-membrane fuel cell.

it has been used only for measurement purposes until very recently. However, fundamental advances in solid-state physics since World War II, together with technological developments in semiconductor materials preparation and fabrication, have led to substantial improvements in efficiency, to the point where this type of converter must now be considered seriously for certain energy conversion applications.

The electric energy generated by a thermoelectric converter is derived from thermal energy; thus, any form of heat source might conceivably be used, provided a heat sink at a lower temperature is available. Combustion of fossile fuels, nuclear fission, radioactive isotope decay, and solar energy are all being considered. For the same reason, however, thermoelectric converter efficiency is limited by the same thermodynamic considerations as that of any other heat engine. Conceptually, the thermoelectric converter is the very essence of simplicity. A number of pieces of p- and n-type semiconductor materials are connected in series

	EFFICIENCY			WATTS/FT³*	$/KW** (PRESENT PROJECTED RANGE)
	MAX OPEN CIRCUIT		FULL LOAD		
	EXPT.	THEORY			
CARBONACEOUS ACID AND ALKALINE	?	91%	STEEP $\Delta\varepsilon$	?	$150 UP
MOLTEN SALT CARBONATE	50-80%	99%	FLAT $\Delta\varepsilon$	100-1000	$150 UP
HYDROX ACID ALKALINE	$\leq$80%	83%	VARIES FROM FLAT TO STEEP $\Delta\varepsilon$	150-1000	$210 UP
LOW T	80%	83%		150-1000	$42 UP
INT T	80%	83%		TO 3000	?

Fig. 7. Known state of the fuel cell art. *Cell only. **Cell only, not installed.

electrically, and some provision is made to keep the junctions of one kind at a higher temperature than those of the other kind by heating and cooling, respectively (Fig. 8). The efficiency of such a converter will depend on the particular configuration used, which must be optimized for each application, and also on a figure of merit for the semiconductor materials employed (Fig. 9). Of course it can never be higher than the ideal thermodynamic efficiency. $(T_1-T_2)/T_1$, for the source and sink temperatures available. The figure of merit is proportional to the Seebeck coefficient (volts per degree) squared, and inversely proportional to the electrical resistivity and the thermal conductivity (Fig. 9).

A very large effort is currently being directed to the problem of increasing the figure of merit, or the temperature, or both. The number of possible materials to be studied is very large (Fig. 10). Most of the groups of the periodic table have some interest. Binary, ternary, and even higher component systems of stoichiometric ratios as well as intermediate ones are at least potential candidates. Thus, although the job of selecting the best material is worse than looking for a needle in a haystack, the possibility that substantial improvement can be made is fairly good. The present status is indicated by Fig. 11. Bismuth telluride has a figure of merit of more than 2, but is useful only at relatively low temperature. Lead telluride has a lower figure of merit at higher temperature. Cobalt silicide has a figure of merit of about 1 at nearly 1,000 C, and therefore

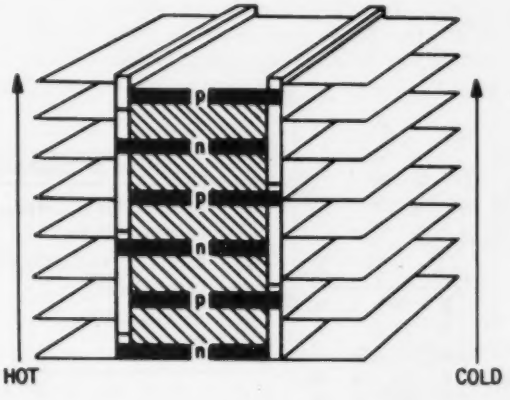


Fig. 8. Schematic of a thermoelectric generator.

$$Z = \frac{S^2}{\rho_\kappa}$$

Z = Figure of merit

S = Seebeck coefficient

ρ = Electrical resistivity

κ = Thermal conductivity

Fig. 9. Factors affecting the figure of merit.

offers the possibility of approximately 15% efficiency. A ternary compound, copper gallium telluride, has a still higher figure of merit, but only slightly better efficiency. The challenge, of course, is to find a material with a figure of merit of approximately 3.0 at 1,000 C (1,832 F) or higher. Such a material could be used to make a converter having at least 30% efficiency. We currently know of no such material, nor can we be sure that one even exists. But it seems to be worth looking for.

Presently known thermoelectric materials, although not economically suitable for large-scale energy conversion, are adequate for certain specialty applications where the inherent-simplicity of this method is attractive. Notable among these are the kerosene-operated radio developed by the Russians, and the low-power space power supplies, using radioactive isotopes, developed in this country. Aside from the semiconductor materials problem, there are also a number of systems problems involving optimum configuration, junction technology, controls, and so on, that merit competent attention (Fig. 12).

THERMIONIC CONVERSION

THE USE OF THERMIONIC EMISSION to generate electricity was first proposed by Schlicter in 1915. Charlton and Langmuir studied the possibility of using a cesium-filled diode as an electric generator during the 1920's. The idea was recently revived by V. C. Wilson and a great deal of work is currently being done on various types of thermionic generators.

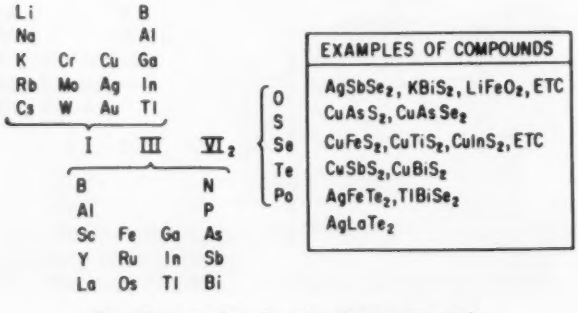


Fig. 10. Examples of semiconductor compounds.

Again the basic idea is rather simple (Fig. 13). Electrons are driven out of a heated cathode by thermal agitation and escape with sufficient energy to migrate to a nearby anode against a potential difference which includes an output voltage across a load. The energy levels involved are illustrated in Fig. 14. In a high-vacuum diode, the electrons must also have sufficient energy to surmount the space charge barrier represented by path *b* in this diagram. The space charge can be minimized by making the cathode-anode spacing extremely small; however, this is difficult to do except in small converter sizes. Another way to overcome the space charge is to fill the space with enough slow-moving positive ions to neutralize the field of the electrons. Cesium vapor has been used effectively for this purpose. Fig. 15 shows a tiny vacuum converter button which is currently in production, and a typical laboratory converter containing cesium.

If the emitter temperature is high enough, the cesium-filled thermionic converter currently operates at an efficiency comparable to that of the best thermo-

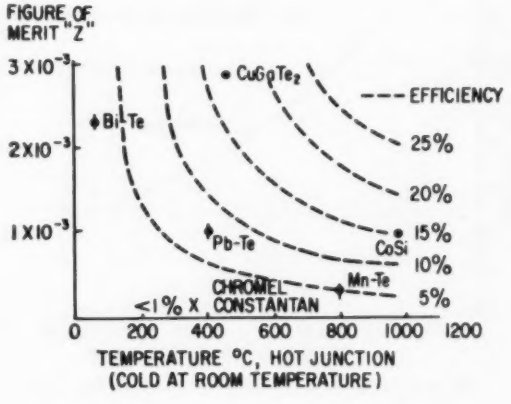


Fig. 11. Examples of semiconductor properties.

electric converters (Fig. 16). Because of its low weight, it should be useful as a solar energy converter for space-power applications. It may also find application as a nuclear reactor topping unit. Preliminary tests indicate that thermionic converters need not be adversely affected by radiation, even if placed inside the reactor core, and that the neutron absorption of such converters can be kept acceptably low.

There are many imposing problems, however, before economically feasible devices can be designed and built. One is the ever present problem of long-life, high-current-density cathodes and low-work-function anodes. Another is the problem of thermal isolation of cathode from anode. Still others involve better methods of fabrication, especially of seals, to maintain accurate spacing and zero leakage. Before such converters can be used in reactors, a great deal more must be known about the long-term effects of radiation. Even the problem of testing full-scale solar thermionic convert-

ers for space use is a formidable one, for it requires a very large, well-collimated light source having the right spectral distribution, in a vacuum environment, with provision for radiating waste energy to a surface approximating a black body at zero degrees Kelvin. There is plenty of opportunity for adventure here!

MAGNETOHYDRODYNAMIC CONVERTERS

IT IS DIFFICULT TO SAY which of many antecedents really represents the beginning of MHD (magnetohydrodynamic) energy conversion. Certainly Faraday had the germ of the idea which is currently being developed. However, it is probably safe to say that the background of plasma physics recently resulting from studies of the upper atmosphere, sun, and stars, and from work on nuclear fusion, as well as the technological advances resulting from ballistic missile nose-cone re-entry work have made it possible only in the last few years to consider seriously the development of such a device. Although by far the most speculative of

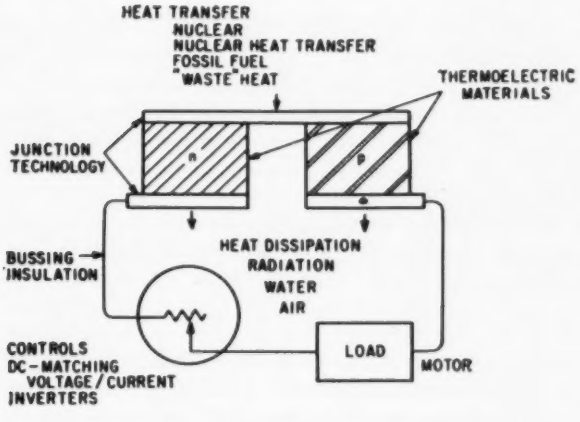
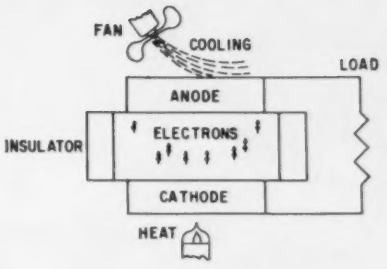


Fig. 12. Thermoelectric power system alternatives.

all the ideas covered in this article, the MHD converter has so much potential merit that it cannot be ignored today.

Given a conducting compressible fluid (plasma), moving at high velocity, there are a number of possible ways to remove electric energy from it. The simplest method, on which most of the effort is focused today, is the old Faraday principle of a moving conductor in a magnetic field (Fig. 17). In order to ionize air to an extent which will make it sufficiently conductive for this purpose, it must be heated to approximately 4,000 K (6,740 F). By "seeding" with an alkali metal vapor such as potassium, the temperature can be lowered to approximately 2,500 K (4,040 F), but this is still a lot hotter than engineers are accustomed to handle, except in the case of nose cones, rocket engines, and electric arcs, where the duration is very short. The easiest way to produce a suitable plasma in small quantity is to

Fig. 13. Schematic diagram of a simple thermionic converter.



heat aid or inert gas in an electric arc. Most experimenters begin in this way. In order to progress to larger-scale testing, however, it is necessary to develop suitable combustion processes. Inasmuch as the required temperature cannot be reached by burning coal, oil, or gas with air at room temperature, the combustion air must be preheated at least 2,000 F, or nearly pure oxygen must be used instead of air.

Work is now in progress at General Electric and elsewhere on a MHD converter of 25 to 50 kw. Unlike the other energy converters described in this article, the MHD generator improves in efficiency as its size increases and would generally be used in sizes of 100,000 kw or more for economic electric power generation; therefore, any statement about the efficiency of these small experimental units would be meaningless. It is significant, however, that the behavior of these small units agrees reasonably well with theory.

The thermodynamic cycle efficiency of an MHD converter alone is not very high because it must reject heat at a temperature determined by the minimum acceptable conductivity of the working fluid, which, as we have seen, is very high. Consequently the MHD converter is generally considered as a topping unit, used in conjunction with a high-temperature steam-turbine generator to increase over-all plant efficiency. Cycle studies based on hypothetical designs of MHD generators lead to predicted values for reduction in heat rate ranging from 15% to 30%, or increases in over-all plant efficiency from around 40% (today's best) to somewhere between 46% and 52%. Fig. 18 is a conceptual diagram of a closed-loop MHD topping unit. An open-loop system would be similar, except that combustion would take place directly in the air before it goes into the MHD generator, outside air would be sucked into the compressor, and the exhaust would go

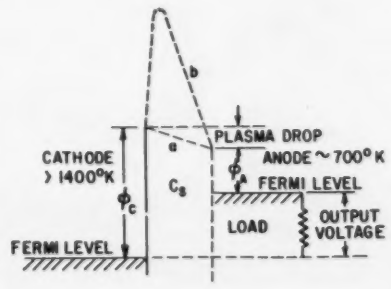


Fig. 14. Electron energy in a thermionic converter.

Fig. 15. J. E. Beggs of the General Electric Research Laboratory displays laboratory models of a vacuum converter (*left*) and a cesium-filled gas converter (*right*).

Type	Efficiency	Weight per unit of power	Emitter Temperature
Vacuum	4½ %	25 lb/kw	1100 C
Gas-filled	17 %	4 lb/kw	1900 C

Fig. 16. Thermionic converter performance.

up a stack after all possible heat had been wrung out of it by preheaters, boilers, and economizers.

There is no longer any doubt that an MHD converter will work—for a little while at least. The immediate engineering problems are concerned with learning how to make it work for thousands of hours without extended shutdown for repairs. The achievement of this goal will depend primarily on whether better materials can be found, or better ways can be found to use the materials we already have. Particularly challenging is the design of the electrodes, the heat exchanger, and the combustor for an open-loop system, especially if powdered coal is used as the fuel.

Fig. 19 shows a closed-cycle MHD converter using a cesium boiler, heated and ionized by concentrated solar energy that may be attractive for space applications. Fig. 20 indicates that a rocket engine in conjunction with an MHD converter could be used to generate large amounts of power in short bursts. Specialized applications of MHD such as this may be closer to realization than economic use in electric utility systems.

ORGANIZATION AND FINANCING

Thus it appears that all of the fields of energy conversion may be attractive to the prospector. There is ample evidence that valuable results may be achieved if only we look in the right places and dig deep enough. The only questions are "Who will put up the grub stake?" and "What kind of prospector is most likely to find pay dirt?"

This kind of prospecting is more like the search for oil that lies deep beneath the ground than like the search for gold and other metals in surface deposits. Large, well organized teams will be needed, including scientists and engineers of many different kinds. Especially important will be the materials specialists for, as we have seen, the limitations of existing materials are critical barriers in every line of development. Intelli-

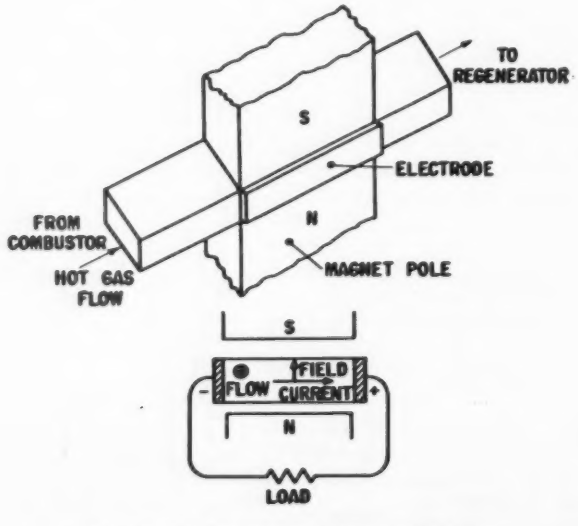


Fig. 17. MHD generator and channel schematics.

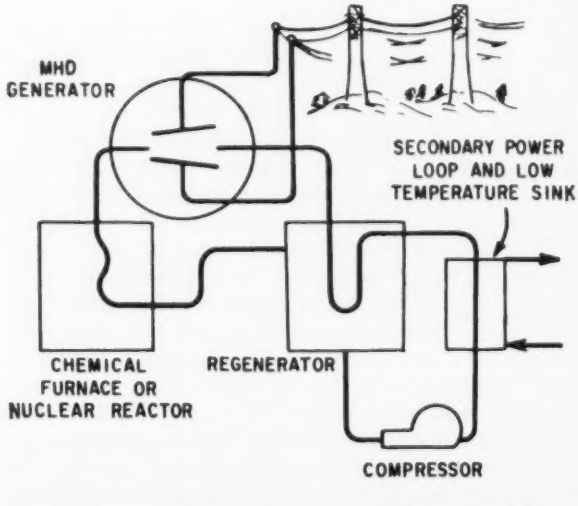


Fig. 18. Schematic diagram of closed-cycle MHD generator system.

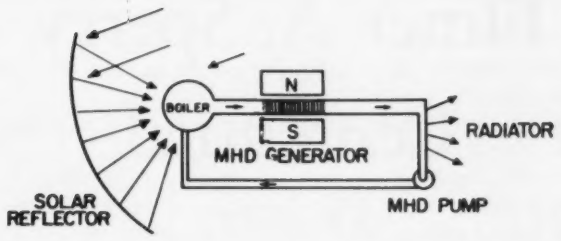


Fig. 19. Closed-cycle MHD generator for continuous operation in space.

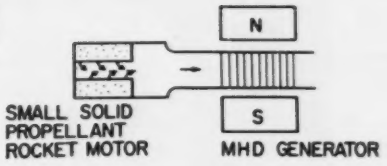


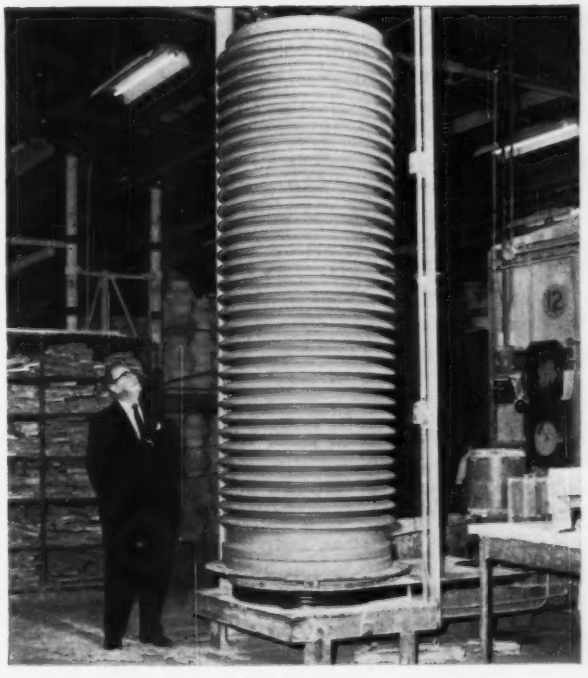
Fig. 20. Open-cycle MHD generator for short burst of electric power.

gent team leaders also are essential, for the work will be extremely expensive in any case, and unless it is properly co-ordinated it may be prohibitively expensive. The management of speculative projects such as this will require a rare combination of imaginative courage to strike out in unexplored directions, and technological judgment to know when to abandon an unproductive line of exploration.

The money question usually boils down to how much Government support should be made available. It would be all too easy to point to other large speculative developments, such as atomic energy, and suggest that the Government pick up the check. Except in the case of certain specifically military energy conversion developments, we should not take this easy way out. The distinguishing feature of free societies, as opposed to Communist and other Socialist systems, is the dependence upon competitive private enterprise as the primary means of economic development. Not only is private enterprise more appropriate philosophically to a free society; it also produces better results, as history has shown, whenever it has been allowed to operate effectively. Instead of asking for Government support, therefore, or just sitting back and waiting for military projects to create the necessary technology for industrial and commercial use, managers of American industry must be willing and able to lay on the line the necessary support for projects such as those we have been discussing, with confidence that if successful, they will be able to retain enough of the benefits to reward them for the risk involved. This is the adventurous way—the American way. I hope we shall have the courage to follow it.

Gargantua of High-Voltage Porcelains

Brent Mills, executive vice-president of the Lapp Insulator Company, Inc., stands dwarfed and somewhat awed beside this king-size porcelain which is now in production in the Lapp plant at Leroy, N.Y. The special porcelain was designed for use in high-voltage equipment rated at 345 kv and is thought to be the largest single-piece porcelain ever made.



In the "green" clay state, as it appears in this photograph, the bushing is over 112 inches long, more than 3 feet in diameter, and weighs approximately 3,200 pounds. After the piece has been dried, it will be glazed, internally and externally, and fired in a special kiln designed for large pieces of this type. A major production problem revolves about the handling of this porcelain before firing. At this stage it is simply dry clay and quite fragile. Elaborate techniques have been developed in the Lapp factory for handling such pieces.

After firing, the porcelain will be ground flat and parallel to a $\pm\frac{1}{32}$-inch tolerance on the over-all length, for gasketing against internal pressure. The porcelain will be tested to 308 pounds per square inch internal hydraulic pressure. The "Fog" type design provides 245 inches of leakage distance.

Elmer A. Sperry Centennial

P. R. BASSETT

Here, for the readers of *Electrical Engineering*, is a brief account of some of the less well-known works of Elmer A. Sperry, who was a charter member of the AIEE, the John Fritz Medalist in 1927, a founder of the Electrochemical Society, and namesake of the Elmer A. Sperry Award, of which AIEE is a co-sponsor.

OCTOBER 12, 1960, marks the 100th anniversary of the birth of one of America's pioneer electrical engineers. Elmer Ambrose Sperry, whose name is almost synonymous with the gyroscope he developed for the service of mankind, was also a giant in the great age of American invention. Long before he began to work with spinning gyros, he had gained world-wide respect for his work with dynamos, electric arc lights, mine equipment, traction cars, and electrochemistry.

The word "game" was the key to Elmer Sperry's philosophy of life. The world was full of possibilities, new things waiting to be done. The game was to digest the problem, be inspired with a new idea, reduce it to practice, file a patent for protection, put it in production, and so obtain some money to start work on the next problem. This was the game he was to play with keen enjoyment from his first day out of school until the day he died at the age of 69. He never retired and his enthusiasm never lagged.

At Cortland (N.Y.) Normal School—a model high school established in his home town in 1886, which boasted such innovations as an excellent course in science, Sperry was introduced to the exciting new field of electricity. Then in its infancy, it consisted mainly of wet batteries, electromagnets, and the telegraph. But new things were happening daily. Young Edison's name was being mentioned for the first time. What great good fortune for Elmer Sperry! He plunged into the science course with his eager enthusiasms, and was soon making his own batteries and winding magnet coils. With his mechanical aptitude and his background of experience in the shops of a local wagon company where his father was employed, he was able to construct practical apparatus. He asked and received permission to build and install an electric-bell system for his school. This he did, even to insulating his own wire.

Only 20 miles away by horse and buggy was Cornell University. In the Physics Department of that institution, Professors William A. Anthony and George S. Moler were planning to build a dynamo. Even the word "dynamo" was new. Although Faraday, a generation earlier, had shown how an electric current could be generated by moving a wire in a magnetic field, no practical device had yet been produced. The scattered attempts throughout the world were called magneto electric machines. But now word came from France that Gramme had produced a practical machine which he called a dynamo; and in Germany, Siemens had made a very efficient unit; and there were rumors that Moses Farmer in Connecticut had a dynamo which ran an electric arc lamp.

The year was 1875. Next year there was to be a great Centennial Exposition in Philadelphia, Pa. The Cornell professors had decided to complete their dynamo of the Gramme type in time to exhibit it at the Exposition. Young Sperry heard of the plans and was soon a welcome visitor in the Cornell laboratory. There was much tedious and meticulous work to be done, such as insulating all the wire by hand, and winding the coils and the armature very carefully. Sperry, already expert at these things, joined in the excitement of getting the dynamo built in time. The hours of wire winding, tedious work for the professors, was high adventure for young Sperry. There was great rejoicing when, that winter, the compact dynamo was first tested and performed perfectly. In March 1876, it was shipped to Philadelphia and installed in the great Machinery Hall with the hundreds of other exhibits.

Young Sperry's trip to the Centennial set his course in life. He was among the first each morning in the great hall as soon as the gates were opened, and there he studied all the varieties of machines, and stood in awed admiration of the huge Corliss engine standing 40

This article is adapted from the early chapters of a biography of Elmer A. Sperry now being written by P. R. Bassett, a long-time associate of Dr. Sperry. Substantial portions of the text are quoted directly from Mr. Bassett's work and to him we extend our thanks for his permission to use this material.

feet high, with its fly wheel 30 feet in diameter running smoothly in perfect silence.

He proudly saw his Cornell Dynamo exhibited in among a lot of small steam engines. In another part of the Hall was a Gramme dynamo from France, and Moses Farmer exhibited three dazzling arc lights supplied from his own dynamo. Edison exhibited his quadruplex telegraph; he had not yet made his first dynamo nor started work on his incandescent lamp. Alexander Graham Bell was creating quite a sensation with his new "talking telegraph."

Sperry was probably the youngest contributor to this first public glimpse of the coming electric age. If this boy could have looked ahead just 16 years to the next exposition held in Chicago in 1892-93, the sight would have surpassed his wildest dreams. For there he would see large sections of the Columbian Exposition illuminated with Sperry arc lights supplied from Sperry dynamos. One of the largest and most beautiful of the buildings would be the Hall of Electricity. Within it would be Sperry motors, Sperry electric mining machinery, an electric mine locomotive, a Sperry trolley car; and just outside the building, on overcast nights, a huge Sperry projector would throw stenciled pictures up on the clouds.

In the period between these two great expositions, the electric age arrived, and in it young Sperry was one of the major participants.

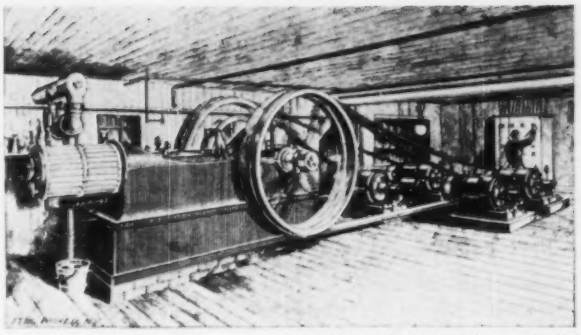
EARLY ACCOMPLISHMENTS

At just about the time Sperry graduated from the Normal School in 1879, he had completed his first dynamo and arc light. There was to be a Firemen's Carnival in Cortland's public square and the committee had no trouble in persuading Sperry, or maybe Sperry persuaded them, that it would be a fine opportunity to exhibit his electric light. The dynamo was installed temporarily in an adjacent mill that had one of the few steam engines in town. The miller permitted Sperry to belt the dynamo to his steam engine, and on the big night the arc light stole the show.

That fall he entered Cornell as a day student, but his heart was not in formal studies. Electric companies were being started in many of the big cities. He wanted to be in at the start, and each month of delay seemed unrecoverable. Furthermore, he did not have enough money to take the full college course. By the summer of 1880 he had built a larger dynamo that could run 10 arc lights.

His father, Stephen, whose travels had taken him all over the east from New York to Illinois, thought that Chicago was the most enterprising city and held the greatest promise for a young fellow like Elmer. In the early fall of 1880, one more Cortland boy left his home town to seek his fortune in Chicago.

Elmer Sperry had two great personal assets—charm and enthusiasm—and these, when backed by an ability to perform, seemed to pave the way. On his 20th birthday he opened his shop on West Quincey Street. The sign read "The Sperry Electric Illuminating and Power Company." Surely a brave front, but he was ready to demonstrate with the units he had brought with him, and within a month he had landed his first order: to install a row of arc lights along the Clark Street facade of the County Building.



From Electrical World, February 23, 1889

Sperry Electric Light Station in which the dynamos are driven by a N. Y. Safety steam engine.

Then came a department store. The installation had three arc lights outside over the sidewalk, and seven throughout the interior of the store. All 10 were in series so that when one lamp stuck and the arc went out, all 10 went out and left the store in darkness—a boon to shoplifters. Store employees also had to watch for red-hot chips of carbon which occasionally fell from the arc lamps into the dry goods on the counters. In spite of these drawbacks, enterprising business in this growing town continued to order arc lights, and young Sperry's business also continued to expand.

The next year Sperry started the first central station in the Chicago Loop. The dynamos were placed in the basement of the Commercial National Bank Building, and the wires were laid under the sidewalks, literally from coal hole to coal hole. This was the same year that Edison in New York was putting in his first central station in Pearl Street.

In the next few years Sperry's business extended to other cities. He made installations in Omaha, Council Bluffs, St. Louis, and Kansas City. But the installation of which he was most proud was the beacon which he placed on the tower of the Chicago Board of Trade Building. Over 300 feet above the street he installed a ring of arc lights aggregating over 40,000 candlepower. They were visible not only from all parts of the city, but even from St. Joseph on the other shore of Lake Michigan. It was the highest and most powerful beacon of its time.

Sperry sold his arc light patents to an electric manufacturing company in Schenectady, which was growing rapidly and gathering in many small electrical manufacturing companies. This company soon merged with the Thompson-Houston Co. to become the General Electric Company.

FROM MINING TO AN ELECTRIC RAILWAY

Shortly after his marriage in 1887, Sperry had an

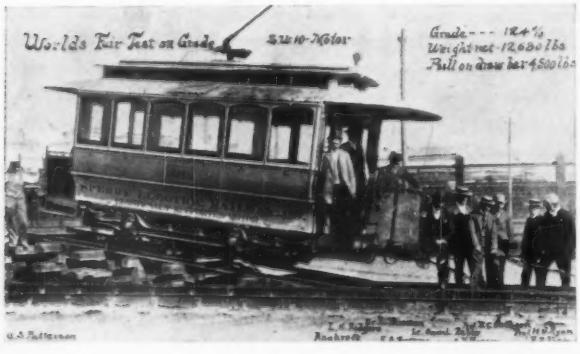
invitation to go down into a coal mine. His ever present curiosity to see how things were done made him take the opportunity.

He was amazed at the primitive methods employed. The miners were using hand picks in cramped positions, and mules pulled the broken coal out in small carts on narrow-gauge rails. Sperry suggested the possibility of electrification, but was told it was impossible, that the corrosive dampness in the mine would destroy copper and all electrical apparatus. That was putting a challenge right in front of him.

Before the year was out, he had designed an electric "puncher" which duplicated the old pick mining with the power of the stroke increased a hundredfold. He had solved the corrosion problem by the simple expedient of keeping the copper wires and the electrical apparatus warm, by maintaining a small current in the circuits at all times. Without delay he formed, early in 1888, the Sperry Electric Mining Machine Company. It was characteristic of him to form a new company while his ideas were still in the formative or experimental stage. It was an indication of his continual optimism, or perhaps a desire to burn his bridges behind him.

The successful use of his coal punchers produced coal faster than the mules could haul, so Sperry designed an electric "mule." This was a locomotive with special characteristics to obtain maximum traction from one motor through multiple wheels. The uneven tracks with numerous curves and grades made great flexibility necessary. The Sperry Mine Locomotive had two articulating trucks of four wheels each, all of which were geared to the single driving motor. The draw bar was placed as low as possible so that the load of the coal cars would not tend to lift the front wheels of the locomotive, which would cause loss of traction. The locomotive was most successful.

In Cleveland in 1889, a group of men, including Myron T. Herrick, later to become our distinguished ambassador to France, was attempting to organize an electric railway system for the city. The terrain was hilly and they needed a good hill-climbing trolley car. Having heard of Sperry's mine locomotive, they approached him and he eagerly tackled the problem.



Cleveland's Sperry Electric Railway Cars won performance prizes at the Chicago World's Fair, 1893.

Trolleys were very new at this time, and with his background of the tough environment of the coal mine, he was able to design a rugged high-performance trolley car which beat all competition. He applied the same basic design of two flexible trucks and eight wheels all geared to a single motor, which he had used so successfully in the mine locomotive. Sperry Electric Railway Company was organized in 1890 to manufacture trolley cars in Cleveland.

During the next few years, this new company built several hundred trolley cars, which were put into operation in Cleveland, Youngstown, Waterbury, and many other places. In Pittsburgh, George Westinghouse had started to manufacture trolley cars. It was a hilly city, so that when the first trolley line was planned, a Sperry trolley was sent in to compete. The Sperry car won the hill-climbing contest, and therefore Sperry had the great satisfaction of beating Westinghouse in his own town and getting the order.

In Philadelphia, the trolley car was welcomed with celebrations. Let the local Sperry representative tell about it. "The Girard Avenue Trolley Line was started last night. All Sperry cars. The Avenue was crowded—red flares, sky rockets, Japanese lanterns, cheers. The first car was filled with officials. Two others followed with a band and business men of the Avenue." Within 2 years, 270 Sperry trolley cars were operating in Philadelphia alone.

"HORSELESS CARRIAGE"

At the Columbian Exposition in Chicago his car won a medal for hill-climbing ability in a competitive test. But once again, when his newest company had become well established, his interest waned. In 1895, the new General Electric Company acquired the Sperry Electric Railway Company and added it to their rapidly growing electric traction department. Sperry was retained as a consultant for a time, but new projects drew him away. The General Electric Company was already too large to interest him. But the whole new field of transportation did interest him, so it was natural that he next turned to the "horseless carriage." The term "automobile" had not yet arrived from Europe.

Sperry was, however betting on electricity. It had simplicity, reliability, cleanliness, and silent operation all in its favor, compared to gasoline and steam. He built his first model in the Cleveland Machine Screw Co. This early car had some features which were far ahead of its time: four-wheel brakes and a nonreacting self-centering steering system. The storage battery, however, was a great disappointment. It gave only about 30 miles on a charge.

This was a field that he knew little about, but as the old well-standardized lead storage battery stood in the way of success, he characteristically set about designing a better one. This must have taken considerable courage. However, he soon proved that what it needed was not chemical or electrical improvement, but a drastic mechanical redesign.

The lead plates were put in porous pyroxylin en-

velopes which held the active material in place, regardless of rough usage. The plates were then put into a lightweight hard-rubber container with an elastic support in the bottom to absorb shocks. These with many other small mechanical improvements made it possible to improve the efficiency and reduce the weight so much that he could obtain 100 miles of travel on a single charge.

With this new car he took John D. Rockefeller, whom he had met at the Baptist Church, for his very first automobile ride. This was before Rockefeller had any idea that the automobile age would bring him many times the wealth that kerosene had already brought him.

In 1896, Sperry took one of his electric automobiles to Paris and there demonstrated it so successfully that he came home with an order for 100 vehicles. To get the proper perspective on just how early in the automobile age this was, we should note that at the same time that Sperry came home with this order in his pocket, Henry Ford in Detroit was starting to build his first automobile; and the Stanley brothers in Boston were starting to build their first steam car. Sperry was indeed a lap ahead.

Once again the time had come to set up a new manufacturing plant. Sperry chose, however, not even to start his own automobile plant, so he sold his rights to the American Bicycle Company, who saw the handwriting on the wall of the coming of the automobile. The car was marketed successfully for many years as the Waverly Electric.

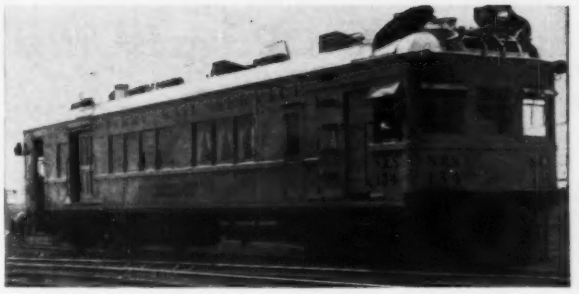
The new lightweight battery which he had developed for this car was such an important element that R. L. Coleman, the president of Waverly Electric Co., formed a separate organization, the National Battery Company, for its manufacture with Mr. Sperry as chief electrical engineer. In 1901, the company was moved to Buffalo where it expanded into the field of railway car lighting, and ultimately was merged with the Electric Auto-Lite Co. to supply lightweight batteries for automobiles.

ELECTROCHEMISTRY

THE STORAGE BATTERY had introduced Sperry to an entirely new field—electrochemistry. He had to start at the bottom. So night after night, following a busy day at his office, he would study at home.

Having mastered the rudiments of the subject, he was ready to start, but he was smart enough to realize that he was still not a chemist. He needed a good chemist as a partner. He had become acquainted in Washington with Clinton P. Townsend, a patent attorney, who was also a chemist. Upon Sperry's proposal that they work together on some electrochemical problems, a laboratory was set up in Washington.

They first tackled the simple reaction of electrolyzing salt water. Though chemically very simple, it was so full of practical difficulties that up to that time, it had not been accomplished on a commercial scale. Soon they had a new cell which they called the Townsend-Sperry Cell, which, by means of graphite electrodes and semi-pervious diaphragms, could produce sodium hydroxide



This self-propelled Sperry Detector Car, owned and operated by Sperry Rail Service of Danbury, Conn., was invented by Dr. Sperry to overcome a serious railroad safety problem. Today, a fleet of cars detect defects in the rails of railroad tracks and mark them for replacement by railroad forces.

at the cathode chamber, and chlorine at the anode. The diaphragm prevented their recombination. The chlorine, by absorption in slaked lime, became bleaching powder, and the alkaline liquor, by evaporation, became caustic soda, both very important basic products.

In 1903, this new process came to the attention of Elon Hooker of Rochester, New York, who had just founded the Development and Funding Company. Hooker employed the best chemist he could find to examine and appraise the development, and then to stay with it during the period of building a trial plant. The young chemist was Dr. Leo H. Baekeland, later to become famous as the inventor of Bakelite.

During 1904, Sperry designed and built three 1,000-ampere cells in Cleveland and shipped them to Brooklyn where Dr. Baekeland set them up in a boiler room of the Brooklyn Edison Co. and supervised their operation. By 1905, they were ready for the next step, and Elon Hooker raised enough capital to build a small plant at Niagara Falls. This was an ideal location, 60 miles from the largest salt mines in the country, with plenty of water and cheap electric power at their door. So started the Hooker Electrochemical Co.

Townsend and Sperry, though retained as consultants, did not move to Niagara Falls, but maintained their independence, and started on their next endeavor. This was an electrolytic process for the manufacture of white lead, a product which had been made for over two centuries by a slow time-consuming method called the Old Dutch Process. Sperry and Townsend succeeded in shortening the time of manufacture from 10 months to a few hours. They produced a fine new product, electrolytic white lead, and some years later Sperry sold the process to the Anaconda Copper Co.

It was in the same year, 1910, when Elmer Sperry had reached the age of 50, that he embarked on a new career, the gyroscope, which in turn brought new, related problems and led him into new fields—precision-instrument making with parts of unprecedented weight, electrical data transmission, servo-mechanism, mechanical computing devices and others. But the story of the gyroscope is another story for another time and place.

French Progress in Railroad Electrification

FERNAND NOUVION

THE Société Nationale des Chemins de fer Francais (SNCF) covers 25,000 miles of route of which 4,000 miles are electrified: 3,000 miles in 1,500 volts d-c and 1,000 miles in 25 kv, single phase, 50 cps. These electrified lines now handle 50% of the total traffic.

Up to 1945, the standard system used in France was the 1,500-volt d-c system, which the SNCF has so improved it now holds the world speed record on rail of 204 mph, attained with a *BB* and a *CC* locomotive in 1955. However, this system appeared too expensive for further substantial electrification; therefore, a more economical solution was sought. At that time two other systems were mainly used: the low-frequency systems (25 and 16⅔ cps), which require special-frequency high-voltage lines, and the 3,000-volt d-c system, the locomotives of which proved to be much inferior to the French 1,500-volt d-c locomotives. Therefore, a new scheme was studied: the 25-kv single-phase industrial-frequency system, which produces a saving of 25% in first costs and 7% on yearly expenses over the 3,000-volt d-c system. The new scheme embodies the following features:

Fixed Facilities—The distance between substations, ranging from 25 to 50 miles, is such that they can be installed either at the existing high-voltage distribution centers, or close to these locations. The ratio of costs can be evaluated at better than 3 to 1 in favor of single phase.

The a-c catenary is made of a bronze tin-bearing messenger of 0.10075 square inch, and a hard copper wire of 0.1658 square inch, resulting in a 20% saving in first costs over the d-c catenaries.

The problems of harmonics and of unbalances do not raise major difficulties.

Rolling Stock. The single-phase locomotives, with static current conversion, outclass the conventional d-c locomotives. Among all the single-phase locomotives used in experiments, the mercury-arc rectifier locomotives have proved to be the best. Three series of this type exist in France:

1. *BB 12000* locomotives (weight 185,000 pounds, 3,360 hp in continuous rating), which have a tonnage rating of 1,650 metric tons on a 1.08% grade. Because of the paralleling of all traction motors and the low traction arrangement, their coefficient of adhesion is very high.

2. *BB 16000* locomotives (weight 185,000 pounds, 4,920 hp in continuous rating), which haul 800-ton passenger trains at a maximum speed of 100 mph on level tangent track.

3. *BB 16500* locomotives (weight 147,700 pounds, 3,500 hp in continuous rating), which are the most economical among the general purpose electric locomotives thanks to the development of technical innovations such as (a) mass-produced trucks with only one traction motor; and (b) utilization of a gear shift permitting a change-over, within a few minutes, from freight (maximum speed 56 mph) into passenger service (maximum speed 93.5 mph).

In freight service, their tonnage rating is 1,525 metric tons on a 1.0% grade, and in passenger service they haul 900-ton passenger trains on level track at 86 mph.

The coefficients of adhesion of these locomotives, equipped with single-motor trucks, are 20% better than those obtained with *BB 12000* locomotives, particularly at high speeds.

With similar performances, the single-motor truck and the gear shifting accomplish a saving of 960 hp and 13 tons of weight, as well as improve the electrical efficiency of the locomotive.

Records show that the availability of French electric locomotives is 90% and that maintenance expenses for single-phase a-c and d-c locomotives are practically the same.

Research is still being carried on to further improve the adhesion in eliminating foreign materials between rail and wheel by means of mechanical processes or by electrical sparking.

Experience gained from a-c locomotive developments helped to improve adhesion of d-c locomotives. Nowadays, in all instances, the starting rheostat is installed at the head of the circuit and parallel starting is provided.

In addition, sensitive slip detectors and antislip electric circuits are being developed. Shunting the traction motor armature, or initiating an antislip action with a balancing resistive bar, has already been tried successfully.

Series *BB 9400* d-c locomotives (weight 132,000 lbs, 2,900 hp in continuous rating) benefit from these improvements. The SNCF is modifying all present 1,500 volt d-c locomotives according to these standards because tests have shown that an 80-ton *BB* locomotive is able to perform the same service as a 107-ton *CC* with conventional diagram.

On single-phase electrified lines, the French National Railroads have now in service, or on order, 318 locomotives with ignition-tubes, 50 *BB 16500* with excitrons fitted for regenerative braking, and one 5,000-hp locomotive equipped with silicon power rectifier.

Digest of paper 60-602, "French Technical Advances in the Field of Railroad Electrification," recommended by the AIEE Land Transportation Committee and approved by the AIEE Technical Operations Department for presentation at the ASME-AIEE Railroad Conference, Pittsburgh, Pa., April 20-21, 1960. Published in AIEE *Applications and Industry*, 1960.

Fernand Nouvion is assistant vice-president, French National Railroads, Paris, France.

Static Control for a Mechanically Regulated D-C Supply

H. J. ABRAMS

J. F. BRUBAKER
MEMBER AIEE

CONVENTIONAL automatic voltage control for a regulating transformer is not designed to detect and correct for fluctuations directly in a d-c line, yet close control of the voltage across the 40-kv rectifier output was required recently for a radar pulsing station. The problem was solved with the design of a new d-c sensing control using two high-gain transistor-magnetic bistable amplifiers and a varistor detector. The low-voltage tap on a bleeder-resistance bank across the 40-kv line is the link that made possible this method of voltage sensing.

The regulating transformer output is applied to a step-up rectifier transformer capable of maintaining a maximum of 40,000 volts on the d-c side of a 6-phase double-way rectifier. During periodic operating cycles, the control must continually measure changes in load voltage and correct for them automatically within the $\pm 16\%$ range of the regulating transformer's 32-step vernier tap changer. An accurate image of the load-center voltage can be made available at the output of such a regulator, when an a-c load is served, through the use of a compensator to simulate line drop. Where the output to be controlled is d-c, difficulty arises in compensating for reactive drop, for it is well established in this type of system that the effective commutating reactance to be considered is not a predictable constant but is dependent on the number of rectifiers being supplied simultaneously through the common source reactance. Conventional a-c sensing and compensation methods were abandoned and attention was focused upon the development of a control sensitive to average voltage deviations in the 40-kv d-c output, shown as point *B* in Fig. 1.

From standard static components, a workable d-c sensing control was developed that shows good promise. Its basic element is the bistable amplifier, acting as a sensitive relay in an on–off system for "raise" and "lower" voltage control. A varistor detector senses changes in the output of the d-c power supply to trigger the amplifier. Fast response, widely adjustable bandwidth and compounding, and a low drift level in respect to varying ambient temperature and supply voltage and frequency, make it particularly suitable when used in conjunction with this pulsing station.

There is no output from the voltage-sensing unit when the input is exactly 200 volts. A signal is delivered to the motor-control relays of the vernier tap changer only when the voltage deviation is greater than the bias

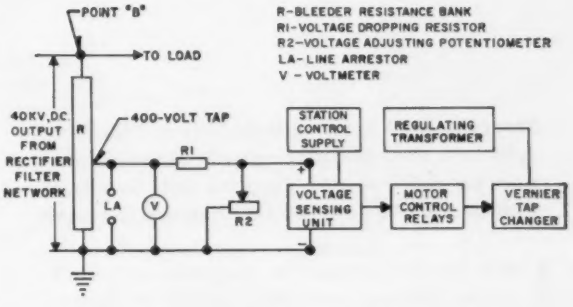


Fig. 1. Block diagram of voltage-regulating control system.

setting of either the raise or the lower bistable amplifier. The effect of tapping in more resistance at *R2* in Fig. 1 is to maintain a lower voltage level on the main rectifier output. Conversely, tapping out more resistance at *R2* has the effect of maintaining a higher output level. With the bistable load, the gain of the varistor detector is about 0.4 volt per volt. The bistable amplifiers in this control combine the advantages of both magnetic amplifier and transistor circuitry,[1] the input stage driving a transistor Schmitt trigger. An output transistor power stage, which is switched by the Schmitt trigger, delivers 24 volts at 210 milliamperes full-wave rectified d-c. Since the first stage is a half-wave push-pull magnetic amplifier, low drift and fast responses are assured. At a maximum of $1\frac{1}{2}$ cycles delay, power gains as high as 10^8 may be obtained. A zener-diode reference circuit is used to supply the bias to the bistable amplifiers so that they may be biased away from the null point of the detector to any degree of bandwidth up to $\pm 5\%$ of the input voltage.

Sensitivity adjustments are made by changing the regulated bias signal to each bistable amplifier from a control accessible on the front of the d-c sensing panel. Controls for changing the feedback to each bistable amplifier are also available at the panel, allowing the compounding to be varied through a wide range. With these adjustments it is possible to achieve a control having as low as $\pm 0.1\%$ bandwidth and 0.038% compounding, although this degree of accuracy is unnecessary with apparatus delivering, as a minimum, 1% voltage changes per step. Realization of this performance despite a $\pm 5\%$ change in voltage and a ± 3-cycle change in the frequency of the station control supply is noteworthy. The control is not limited to regulators of the step type, but may be used in a wide variety of applications where the output to be controlled is d-c.

Digest of paper 60-783, recommended by the AIEE Magnetic Amplifiers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Communication and Electronics*, Sept. 1960.

H. J. Abrams is with the Norbatrol Manufacturing Corporation, Pittsburgh, Pa.; J. F. Brubaker is with the Westinghouse Electric Corporation, Sharon, Pa.

REFERENCE

1. A Sensitive Static Relay Circuit, John Rosa. "Proceedings, Special Technical Conference on Nonlinear Magnetics and Magnetic Amplifiers," AIEE *Special Publication T-116*, Sept. 1959, pp. 154-66.

Special Positions for Person-to-Person, Collect, and Credit Card Calls

L. FREERICKS
MEMBER AIEE

The constantly growing telephone toll traffic results in a corresponding growth in switchboard position requirements. Facilities and circuits introduced to alleviate this situation are discussed.

THE steady increase in telephone toll traffic requires an ever increasing growth in facilities to handle this traffic. A large number of toll calls require the assistance of an operator for completion and result in increasing requirements for switchboard positions. The actual growth in position requirements is not uniform but is affected by the business cycle and changes in dialing arrangements. The toll growth in New York City has varied in past years from a low of 2% to a high of 12% and averages around 7%.

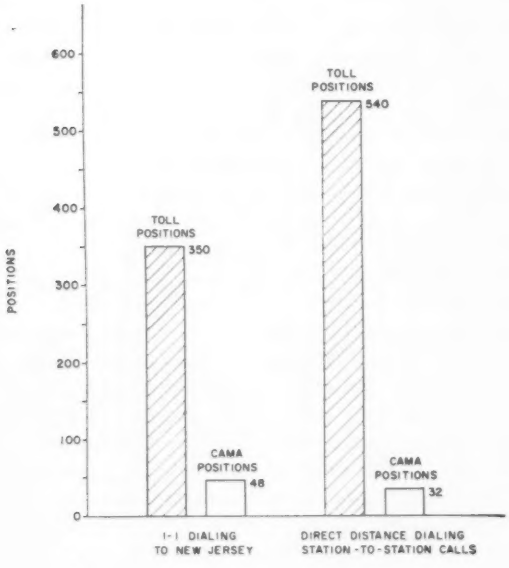


Fig. 1. Chart showing toll positions saved compared with CAMA positions required for 1-1 dialing and direct-distance dialing service. Note: Shaded stacks represent toll positions saved. Associated nonshaded stacks represent CAMA positions required to handle equivalent traffic.

Relief in position growth has been obtained in two recent upswings in traffic by providing facilities permitting the customer to dial calls directly that previously required operator assistance. One of these, in 1956, was the provision of 1-1 dialing of calls to New Jersey. The other, started in 1959, was the arrangement for direct distance dialing of station-to-station type calls. Fig. 1 illustrates graphically position savings resulting from these two arrangements.

Without the advantages of these dialing arrangements, Manhattan alone would require an average annual addition of between 200 to 250 positions. Space shortages already exist in most Manhattan central office buildings. New operators are hard to get and require training. These are some of the reasons for seeking further ways of mechanizing calls to reduce operator work load.

The arrangements for direct distance dialing of station-to-station calls have alleviated the position growth problem for the present. However, a study of the position requirements for nine midtown central office buildings is shown in Table 1. These results are based on an annual growth of 5% in toll traffic. Even with this assumption, position shortages will start to develop in the West 50th and West 36th Street buildings in 1962 or 1963 depending on the business cycle. Position shortages will begin to develop on the East Side about a year later.

Many calls, such as person-to-person, collect, credit card, time and charge radiotelephone, etc. still require the assistance of an operator. These are high coefficient calls requiring long operator work time. In Manhattan, 75% of the toll calls from business telephones to points

Table 1. Toll-DS "A" and DS "A" Position Study for Manhattan. (Includes Effect of DDD Operation.)

Toll-DS "A" Bldgs.	Pos. Eqpt.	Position Requirements					
		1-1-59	1-1-60	1-1-61	1-1-62	1-1-63	1-1-64
East Side							
2nd Ave.	150	121	110	115	120	126	132
E. 30th St.	282	191	192	215	228	239	250
E. 37th St.	324	258	242	263	280	303	324
E. 56th St.	258	225	215	227	239	251	264
TOTAL	1014	795	759	820	867	919	970
West Side							
W. 18th St.	195	169	164	177	191	203	212
W. 36th St.	342	321	312	328	346	364	373
W. 50th St.	372	328	319	336	354	372	392
W. 73rd St.	48	40	42	39	41	44	46
Manh. Ave.	66	47	51	42	45	48	53
TOTAL	1023	905	888	922	977	1031	1076

Note: Positions required are based on annual growth of 5% in toll traffic.

Essentially full text of CP 60-818 presented at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960.

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over 24 miles distant are placed on a person-to-person basis.

In October of 1956, after a study of position requirements, the American Telephone and Telegraph Company (AT&T), Bell Telephone Laboratories, and the New York Telephone Company decided to proceed with a trial of customer dialed person-to-person, collect, and credit card calls. From the results of the trial it was hoped to determine: (1) customer reaction and the degree of customer acceptance; (2) traffic operating methods; (3) system requirements for recommendation to AT&T for the development of standard facilities.

A No. 5 crossbar office, Yukon 8, was being installed at the East 79th Street building at the time and it was decided to use this as the trial office. The features of No. 5 crossbar provided automatic number identification and automatic message accounting which simplified, to some extent, the necessary circuit development work.

An addition was being planned for the No. 5 crossbar office at Poughkeepsie, N. Y. A crossbar tandem CAMA (centralized automatic message accounting) office is also located at Poughkeepsie. It was decided to use this as a trial location and to combine the person-to-person features with the CAMA position features.

SWITCHING PLAN

THE CUSTOMER wishing to place a person-to-person call was to be instructed to dial a zero prefix ahead of the regular 7 or 10 digits of the called number. The call would proceed to completion in a manner similar to a station-to-station call except that, before completion, an operator at a special position would be bridged to the connection. A tone signal would alert both the operator and the customer. The customer would pass necessary information to the operator. In the case of a person-to-person call, this would merely be a statement of the called individual's name, such as "I would like to speak to Mr. Watson." When the called station answered, the operator would monitor the call long enough to determine that the proper party was connected and then operate a class-of-charge key, in this case "per paid" and a start-timing key. This would cause an entry on the LAMA (local automatic message accounting) tape to record details of the call and release the position. The connection between the calling and called stations would remain until the end of conversation. The disconnect entry is put on the LAMA tape by the trunk in the regular way upon customer disconnect.

In order to provide these features, extensive modification of standard circuits and development of several new circuits was necessary. The block diagram of Fig. 2 indicates the major circuits involved and shows circuits requiring modification and new circuits.

The "originating register" must recognize the "zero prefix" and pass the information on to the "completing marker." A delay had to be introduced if the first digit received was a zero. If no further digits were recorded, the call had to be routed to the regular assistance

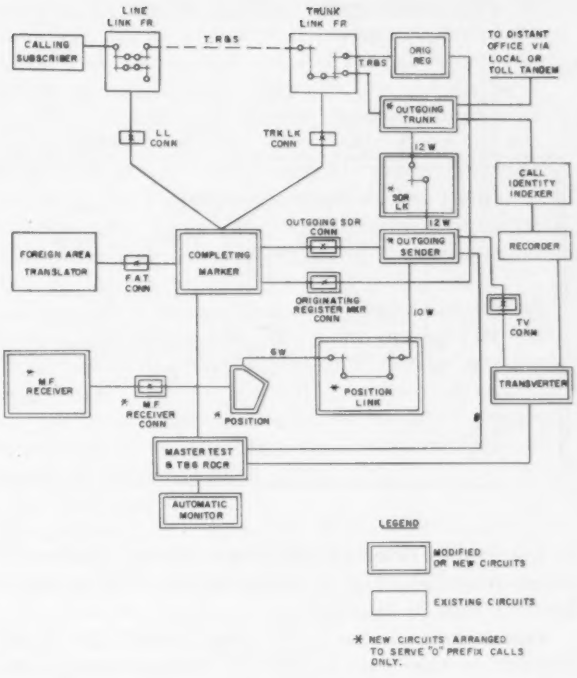


Fig. 2. Switching plan of connection for a person-to-person direct distance dialing call.

operator. A delay of 3 to 5 seconds was considered as sufficient for this purpose. Additional digits received during this period cause the register to recognize a zero prefix call.

The completing marker required modification to recognize the new type of call and to handle the proper routing of the call.

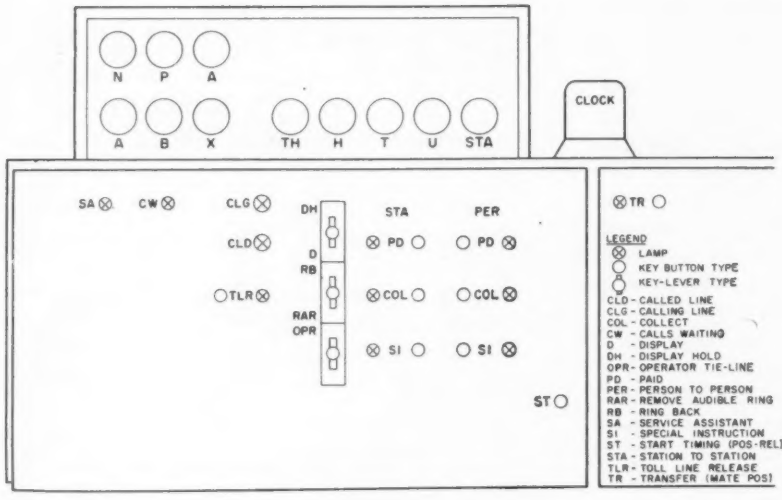
The outgoing "multifrequency sender" required extensive modification. In addition to the normal sender functions, it was necessary to connect to a position before allowing the call to complete. The talking path from the outgoing trunk to the position is provided through the sender. The sender also must record the type of charge set up by the operator and pass this information on to the "transverter" for entry on the AMA (automatic message accounting) record. It must also send the called number information to the position when it is required.

The outgoing trunk had to be arranged to provide for the bridging connection to the position through the sender.

The transverter required modification to pass additional information on to the recorder.

New sender and position links had to be developed to provide connections between the associated circuits, and minor modifications were required on the "originating register marker" connector, "outgoing sender" connector, and transverter connector.

A new position was required for this service. Fig. 3 shows the position keyshelf in schematic form. Fig. 4 is a representation of two position sections back-to-back


N P A
A B X TH H T U STA
CLOCK
SA CW CLG CLD TLR DH D RB RAR OPR STA PER PD COL SI ST TR
LEGEND
LAMP
KEY BUTTON TYPE
KEY-LEVER TYPE
CLD - CALLED LINE
CLG - CALLING LINE
COL - COLLECT
CW - CALLS WAITING
D - DISPLAY
DH - DISPLAY HOLD
OPR - OPERATOR TIE-LINE
PD - PAID
PER - PERSON TO PERSON
RAR - REMOVE AUDIBLE RING
RB - RING BACK
SA - SERVICE ASSISTANT
SI - SPECIAL INSTRUCTION
ST - START TIMING (POS-REL)
STA - STATION TO STATION
TLR - TOLL LINE RELEASE
TR - TRANSFER (MATE POS)

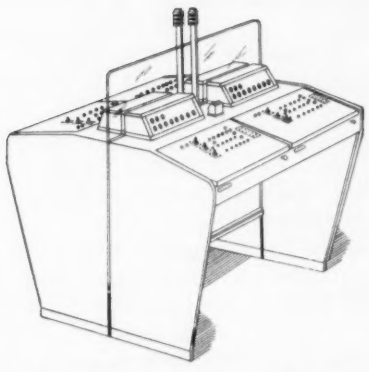


Fig. 3. *(left)* **Person-to-person special position keyshelf layout and display panel.**

Fig. 4 *(above)* **Combined CAMA and person-to-person position.**

as installed at Poughkeepsie. Fig. 5 shows a line-up of the positions, and Fig. 6 is a photograph of the position keyshelf used in Manhattan.

The six keys and associated lamps to the right of the keyshelf in Fig. 3 are for the six classes of charge the position can handle. Three classes each are provided for person-to-person and station-to-station type calls. They are prepaid, collect, and special instruction.

On a prepaid-type call the operator need only verify completion to the proper number or person and depress the proper key, Sta-Pd or Per-Pd.

On a call for which the distant station agrees to accept the charges the operator will depress the proper COL key.

Certain calls, such as a request that charges be billed to a number not directly involved in the connection or credit card charge calls, require the operator to keep a written record of specific details. On this type of a call, the special instruction (SI) key is depressed. The accounting people are later required to match the operator's written record with the AMA tape record.

In any case, the operation of the start-timing (ST) key is required to cause the entry to be entered on the AMA tape.

Three lever-type keys are provided in the middle section of the keyshelf. The top key is designated DH in one direction and D in the other. This key is used along with the display panel mounted on the rear top of the position. Eleven neon-type numerical display tubes are mounted in the display cabinet. If for any reason the operator requires the number of the called station, the operation of key D will bring up the display on the panel. The three indicators in the top row give the code of the "numbering plan area," the eight indicators in the lower row give a display of the called central office code and subscriber's number with a party letter if required. The display is obtained from the record in the outgoing sender by means of multifrequency pulses.

If the operator wishes to hold the display on the position after the position is no longer connected to the circuit, the DH key operated will hold the display and also prevent other calls from coming in on the position.

The RB key is used to apply ringing current to the calling line to alert a PBX operator who may have gone off the line due to a delay.

The RAR key is used to open the transmission circuit to the called end if ringing or other tones interfere with conversation between the calling station and the operator.

The OPR key connects the position to an operator at the regular toll board. This may be used when the call has encountered a delay and the customer has requested the operator to try to complete the connection at a later time. Details of such a call can be given to the operator at the toll board.

The toll line release (TLR) key is operated if some difficulty is encountered in the completion of a call and conversation between the calling customer and the operator continues. The TLR key operated releases the call to the distant end to prevent holding the circuits out of service unnecessarily.

The CLG and CLD lamps are calling and called party supervisory lamps, respectively.

The CW lamp shows that additional calls await handling and no idle positions are available.

The SA lamp lights when the service assistant key, in the position lock rail, is operated. The service assistant is available if the operator has any difficulty with the handling of a call.

The transfer (TR) key is used to transfer the operator's head set to the adjacent position. If a long delay is encountered on a call, during which the operator can only sit and wait, and the CW signal indicates calls are waiting to be handled, the operator may operate the TR key and handle a call on the adjacent position if it is vacant.

The position at Poughkeepsie also handled regular crossbar tandem CAMA traffic and a numerical key set is provided for this purpose.

TRIAL AT YUKON-8

THE EQUIPMENT WAS INSTALLED in the Yukon-8 central office in Manhattan and placed in service early in June 1958. Yukon-8 is a no. 5 crossbar office at East 79th Street and the special positions were installed in a telephone building at East 56th Street. The 79th Street area is essentially residential and the person-to-person type traffic is comparatively light. The service was therefore offered to a number of business customers with a high person-to-person calling rate, in the East 56th Street area. The customers that agreed to participate in the trial were provided with special groups of PBX trunks to the Yukon-8 central office. These trunks were to be used for all of the toll calls originated by the customer. The desired average busy day load of 1,000 calls was obtained in this way.

The feature was put in service in Poughkeepsie in October 1958.

The results of the trial were highly satisfactory. The service received enthusiastic acceptance by the customer. Better than 97% of dialable calls are being dialed directly. A considerable saving in accounting procedures has resulted from the AMA recording of the calls. Results of traffic studies indicate that each of the special positions provides relief for two regular toll positions.

Fig. 5. Line-up of person-to-person positions.

AT&T has approved the further development of arrangements for the direct distance dialing of person-to-person calls. The system development plans to use the crossbar tandem system to provide these features. The service can thus be made available to all of the various types of central offices that have access to crossbar tandem. The features of centralized automatic message accounting can thus be readily adapted for use by offices not arranged for local AMA.

IMPROVEMENTS NEEDED

THE TRIAL ALSO REVEALED the need for a number of improvements in the original arrangements and for some new features. The most important of these new features is the provision of a service for extension identification or code billing. Normally, the charges for a particular call are billed to the directory number of the line on which the call was placed. There are several business concerns that require charges be associated with the extension from which the telephone call originated. There are other business concerns that require charges be associated with a particular customer's account.

This service is being provided at present by having the party placing the call inform the operator of the need for identifying the extension or account number with the call. The operator fills in a written record, usually a "mark sense" card with the necessary details. The accounting department people are then required to match this with the AMA record when preparing the bill for the customer.

The addition of a numerical keyset to the position and modification of associated circuits would permit the operator to key pulse the identified number for recording on the AMA tape.

These refinements are all planned for the "system standard" arrangement using CAMA tandem. A new general purpose switchboard position is planned for this project. This job will require considerable development effort and is not expected to be ready for service in quantity before 1965.

Position relief will be necessary in a number of locations before the new system standard arrangements are available. A special group at the Bell Telephone Laboratories are now developing the circuits used in the New York trial to provide the new features and improvements. These are expected to be ready for service early in 1961 and will provide for position relief until the system standard arrangements are available.

The trial circuits may well become the basis for a system standard in smaller communities for use with no. 5 crossbar where a crossbar CAMA tandem installation would not be justified.

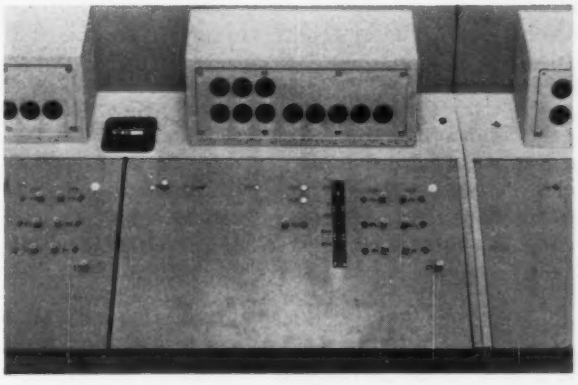


Fig. 6. Person-to-person keyshelf.

Insulation Control Measurement Considerations

G. F. LANG
MEMBER AIEE

Numerous problems are involved in developing effective measuring techniques for the evaluation of insulation of large-size machinery. Some observations, based on research being conducted in this field by a manufacturer in France, are presented.

IN REGARD TO the insulation of large-size machinery, the engineer has two main concerns:

1. The development of a safe and effective insulation.
2. The investigation of measurement methods which will allow the quality of the insulation to be evaluated, their weak spots to be detected, and aging data to be gathered.

In whatever form it is used, mica remains, in most cases, the basic material of the insulation. It is backed with paper or glass and bonded with resin. In recent years a synthetic resin of the polyester or epoxy type has been used.

Two general methods are used for applying the resin. It is either incorporated directly into the mica tape before its application or it is applied by impregnation after taping. Vacuum treatment is used in practically every case.

The first machine insulated according to modern practices with continuous mica insulation made from large splittings and vacuum- and pressure-impregnated with a suitable polyester resin was placed in service in France in 1954. This method was investigated and perfected in the United States. Since then, two French firms, one Belgian firm, one Italian firm, and one German firm have adopted it. Units totaling several million kva are now in service. Other insulation systems have appeared on the European market, but practical applications are fewer, inasmuch as their development and commercial introduction are more recent. However, this does not make them less interesting.

MEASURING METHODS

THE PROBLEM of measuring methods has been the subject of heated discussions, even in the international field, thereby clearly showing it is important and new at least in its present form.

As far as these measurements are concerned, it is desirable in particular:

1. To try to evaluate the quality of the insulation of a given machine at a given moment. This evaluation is particularly interesting for controlling the winding of a new machine before it is put into commercial operation.
2. To estimate the rate of aging of a given insulation with time, and thus observe its development.

The latter case falls under the category of maintenance. Whereas the first case concerns especially the manufacturer, the second is very important to the user.

Let us now examine briefly the chief means actually at the insulation engineer's disposal.

On coils, it is possible to measure with a Schering bridge the variation of the power factor and capacitance as a function of the applied voltage.

The power factor level at a given voltage is now hardly used. The notion of ionization inception voltage defined by the position of the bend of the curves is questioned. Actually, ionization inception is indicated by the voltage at which discharges occur in the air spaces contained in the insulating barrier. These discharges increase the losses and, therefore, the power factor rises.

Now, we know that when the thickness of an air gap increases in a given insulating barrier, the ionization inception voltage first decreases, reaches a minimum for a very definite air gap thickness, then increases. Furthermore, this minimum occurs for a relatively small air gap thickness.

Under these conditions, it is easy to understand that in a complete coil there may be one or even several small pockets with a thickness which happens to correspond to minimum ionization inception.

In certain insulating systems containing among other defects large air spaces, the inception of ionization of the small void may not be shown by a Schering bridge measurement because it is concealed by the much larger bend due to thick air gaps with higher ionization inception voltages.

It is by applying these arguments that certain specialists deny at present the usefulness of a measurement of the ionization inception voltage of an insulating barrier intended for rotating machinery.

On the other hand, if the ionization inception notion is losing more and more ground, another theory has appeared which consists in finding, still by means of Schering bridge measurements, the magnitude of the ionization instead of the ionization inception voltage. Actually, ionization causes losses and, therefore, changes the value of the power factor. By taking as a basis the increase and, therefore, the slope of the power factor

Essentially full text of a paper presented at the Foreign Practices Session of the Second National Conference on the Application of Electrical Insulation, Washington, D. C., Dec. 8-10, 1959. Recommended for publication by the AIEE Electrical Insulation Committee.

G. F. Lang is with Schneider-Westinghouse, Champagne, France.

curve as a function of voltage, it is possible to get an idea of the magnitude of the ionization and, therefore, of the voids.

Actually, this method seems to offer various disadvantages. In particular, it does not allow the comparison of different insulations or of coils of different geometry. Also, the size of the electrodes influences the measurements.

In addition, the determination of the voltage levels at which the power factor should be measured to calculate the slope is very delicate and, in some cases, the power factor slope is found to be less for an insulating barrier which has neither been impregnated nor treated by vacuum than for an insulating barrier made according to modern manufacturing methods. This is of course not normal. This apparent anomaly is explained by the fact that the ionization inception voltage of such a coil is very high.

Personally, we use a criterion which seems to us more significant. It consists of finding, still by means of a Schering bridge measurement, the relative variation of the capacitance measured at two different voltages. The first is very small and definitely lower than the ionization inception voltage. The other is high and equal to at least 1.5 times the phase-to-phase voltage of the machine. Ionization is high at this voltage. It affects practically all the voids, even the thickest, and partially short circuits them. The result of this is a variation of the capacitance of the insulating barrier of the order of 1 to 50% and even more, according to the surface and the thickness of the air gaps.

This criterion is defined by the relation:

$$\frac{C_H - C_L}{C_H}$$

where

C_L = capacitance measured at low voltage
C_H = capacitance measured at high voltage

The value obtained is dimensionless.

It can be shown and confirmed experimentally that the over-all measurement of this criterion made on a set of coils is equal to the average (with capacitance weighting) of the elementary criteria measured on each coil individually. As it is based on a geometrical capacitance measurement, it is only conditioned by the relative size of the voids. It is independent of the chemical composition of the insulating barrier. Owing to these two characteristics, its use is universal and fairly practical and may include the accurate location of an area containing a large void.

Although there is still a lot to be said, we have dwelled somewhat on measurements which apply to one coil only. We feel, a priori, that the foregoing principles may also be applied to a complete winding. Supporting data are not yet available, but tests are now being made.

In the case of complete machines, ionization measurements are not yet entirely satisfactory. We must, however, call attention to the existence of a method commonly used in France. It consists of measuring, in a given frequency band, the rms value of the current resulting from the discharges caused by ionization of the voids. An instrument has been specially designed for this purpose and considerable data have been obtained. It is certain that ionization is a vast problem and that much work is still necessary in order that this phenomenon may be studied thoroughly.

DEGRADATION BY DISCHARGES

By going back to the beginning of the problem, we realize that what we are trying to do primarily is to reduce, if not suppress, the degradation of the insulating barrier by discharges. Two factors influence this degradation:

1. The nature of the insulating material, i.e., its resistance to ionization (ionic bombardment and chemical attack).
2. The magnitude of internal discharges, i.e., their amplitude and frequency—therefore their severity.

At the present stage of our knowledge, it would be difficult and probably impossible to develop either a material completely insensible to ionization or an insulating barrier free from the smallest void.

It seems, on the other hand, more proper to consider studying the definition of an ionization level where the material involved will have a reasonable life. This level could be termed "injurious ionization inception voltage."

It is important to note that ionization is a local phenomenon and that it would therefore be better not to make over-all ionization measurements, but to try to locate and measure the most important discharges instead of attempting, for example, to find the general level for a complete machine.

To investigate the resistance of materials to ionization attacks, we are at present using a cell producing a point discharge which attacks a well-defined area of the insulating material involved.

The criterion used is the quantity of electricity, expressed in coulombs, required to cause the breakdown of a given thickness of insulation. In addition, this cell has the advantage of being simple, small, and inexpensive. A hundred cells can easily be placed in a normal laboratory oven. It allows the study of the discharges and of the parameters affecting them. Among these parameters let us mention in particular the number of discharges per supply voltage alternation, the frequency of this voltage, the air-space thickness, and the amplitude of the discharges.

There are, of course, other types of cells. They form the subject of articles which we could not discuss without repeating ourselves. Their existence clearly proves the existence of the problem and of the interest aroused.

We have just made a rapid survey of the problems of ionization in an insulating barrier. It is a rapid one if we consider the magnitude of the subject, but a broad one if we think of the number of insulation problems in rotating machinery alone.

OTHER PROBLEMS

THE INSULATION ENGINEER has other problems on his agenda. Among them we find the high-voltage d-c tests which are extremely important. Some people consider these tests the most valuable, inasmuch as they do not stress the insulation as much as other tests.

The value of $\alpha = 1.6$ now accepted in several countries seems logical and could even satisfy, in most cases, people who consider that the stress in the ends of the coils is excessive when d-c test voltages are employed.

We know that d-c tests have the advantage over a-c tests of enabling nondestructive measurements to be made. However, it is necessary to be able to make use of this advantage.

We believe one of the methods consists in measuring the conduction current of similar elements of the same machine and comparing the results obtained. For instance, it is always possible to compare the three phases of the same machine. If the leakage current of one of these three phases is greater than that of the two others, or if the variation of this current as a function of the impressed voltage is different, it may be useful to find the cause of this condition. We can then consider dividing the phase involved into similar elements and so locate step by step the spot causing the measurement anomaly. It then rests with the insulation engineer to estimate the seriousness of the possible fault, that is to say its repercussion on reliability.

But in this type of investigation it seemed to us useful to emphasize the fact that a measurement anomaly is not necessarily due to a weak spot presenting a danger in operation. In addition, we must make it quite clear that all defects cannot be detected by this method, which should be considered only for obtaining additional information and not as an unrivalled method replacing all others. On the other hand it offers the advantage of neglecting the measurement levels and taking into account only the relative values obtained by comparing similar elements either in identical machines or in identical circuits of the same winding.

It certainly does not seem reasonable to compare the results of measurements obtained on machines which differ either by their capacity and voltage or by their design, manufacture, and insulation.

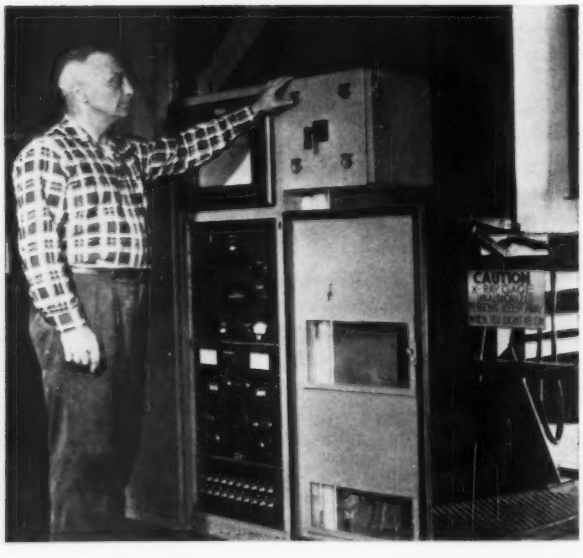
However, there is still one point to explain, that of the voltage at which the measurement must be made. We believe that in a machine in good condition, say less than 10 years old on an average, the d-c voltage applied to make these measurements may be about twice as high as the phase-to-phase voltage without unduly stressing the parts of the winding extending beyond the core. On machines offering clear signs of stress, measurements should be made at lower values.

CONCLUSION

IT IS VERY DIFFICULT to conclude such a vast subject which has been scarcely approached. We can only bow to its magnitude, both as regards quality and quantity, and postpone to a later date the adoption of definite procedures which, because they are reasonable and unquestionable, will satisfy both users and manufacturers.

We shall close, therefore, expressing the wish that all the fascinating problems concerning the insulation of large machines will be solved, owing to an ever-increasing knowledge of the various phenomena which affect them and to an ever-closer co-operation between the insulation engineers of different countries.

X-Ray Tin-Coating Gauge



Fred Pierallini presses the "start" button on a new Norelco type *U* tin-coating gauge in a test-run operation at the Irvin Works of U. S. Steel Corporation, Pittsburgh, Pa. Behind the caution sign in the photo is the opening through which the tin-coated steel will pass, traveling at speeds from 800 to 1,100 feet per minute. The X-ray gauge head moves horizontally on a traveling mechanism that traverses the moving strip to check tin-coating thickness on one side of the steel. The Irvin gauge will measure tin thickness continuously in a range from 0.1 to 0.55 pound per base box.

Installed by Philips Electronic Instruments, Mount Vernon, N.Y., the X-ray machine incorporates a unique Norelco wedge aperture which automatically compensates for flutter of 1/8 inch up and down (1/4 inch total) as the steel sheet passes along the rolls. Previous models have a flutter tolerance of only 1/16 inch up and down (1/8 inch total) and require much greater power on the X-ray tube.

An Electronic Teleprinter Distributor

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MOST of the extensively used teleprinters of today have mechanically operated cam-type distributors. Although these are quite satisfactory and reliable, a recent trend in the industry has been to develop electronic distributors. A distributor of this type has been developed at the Electrical Engineering Laboratory of the University of Roorkee, India. It uses eight cold-cathode thyratrons or trigger tubes connected as a ring counter. One of the tubes keeps glowing and maintains marking current in the line when the transmitter is idle. When a character is transmitted, the tubes fire one after another in a serial sequence. The timing pulses are derived from the 50-cycle mains supply. Although any fluctuation of the supply frequency will affect the output waveform, it has been seen that if the frequency variation is limited to 4%, a teleprinter receiver having a margin of 35% will function properly.

A high-speed polarized telegraph relay acts as the output relay of the distributor. The single-pole double-throw contact of the relay can be wired to provide either neutral or polar operation.

Another high-speed relay similar to the output relay but having a double-pole double-throw contact functions as the control relay and performs three important operations. When the distributor is working from the keyboard, it may happen that the operator keeps the key depressed for a period longer than the transmission time of a signal. Under this condition, the transmitter should transmit the signal only once. The control relay prevents this undesirable repetition of the signal. In case the operator keeps the key depressed for a period less than the transmission time, the control relay keeps the locking mechanism in operation until the transmission is over.

A stop pulse of 1.5 units duration is obtained in this distributor by reversing the phase of the sinusoidal supply driving the pulse generator by means of the control relay in conjunction with an odd and even pulse counter. The pulse which terminates the transmission of the fifth code element and commences the transmission of the stop pulse is also applied to the input of the odd and even pulse counter. Thus, the state of this counter changes every time a stop pulse is transmitted. This property is utilized to reverse the phase of the sinusoidal supply. Fig. 1 shows the oscillograms of the sinusoidal supply, the pulses and the output waveform when the distributor was made to transmit the code for letter *D* continuously. The oscillograms were taken by feeding these three quantities simultaneously on three elements of a 6-element magnetic oscillograph.

The distributor can work both from a keyboard and from a tape reader. It also has a run-out key which enables repeated transmission of any character. Sometimes in certain languages, as in India, the number of alphabets and their various forms may be more than a 5-unit code can represent. It is desirable, therefore, that the distributor has the provision of working from a 6-unit code as well. In this distributor, this facility has been provided by simply having one more tube in the ring counter. The circuit of this tube is essentially the same as any other tube of the ring counter. When the transmitter is working from a 5-unit code, the code selector switch takes the tube out of the ring counter and brings it in when the transmitter is required to work from a 6-unit code.

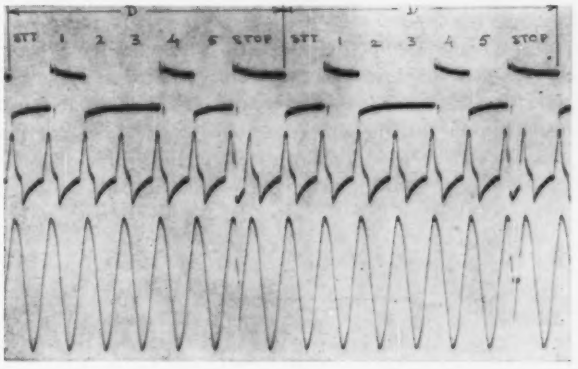

Fig. 1. Oscillograms showing the phase reversal of the sinusoidal supply, the pulses, and the output waveform.

No hot-cathode tube has been used at any stage of the distributor and, therefore, it does not require any warm-up time. However, it has one important limitation; that is, it can transmit only at one speed, which is 50 bauds. In the United States, where the supply frequency is 60 cycles per second, the distributor will work at a speed of 60 bauds. A flexibility of speed, however, can be obtained by incorporating a variable frequency oscillator to drive the pulse generator. The chief advantage of this design is that the timing oscillator remains free running and there is no need to double its frequency during the stop period to obtain a 1.5-unit stop pulse.

Digest of paper 60-770, recommended by the AIEE Telegraph Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Scheduled for publication in AIEE *Communication and Electronics*, Nov. 1960.

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Analysis of the Bridge Magnetic Servo Amplifier

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THE OPERATION of a half-wave bridge magnetic servo amplifier, in which the load circuit includes the resistance and inductance of a servo motor control winding shunted by a tuning capacitor (Fig. 1), will be examined.

A rigorous analysis, considering the reactive load on the amplifier, shows that the limiter volt–seconds (i. e., the blocking volt–seconds across the self-saturating diodes) available during the reset half cycle of the amplifier, exceed the volt–seconds supplied by the power supply, which is not the case with purely resistive loads. These extra volt–seconds are supplied by the load itself. The voltage across the inductance and capacitance of the load during the reset half cycle is in such a direction as to aid the supply voltage in blocking the self-saturating diodes associated with the core which is

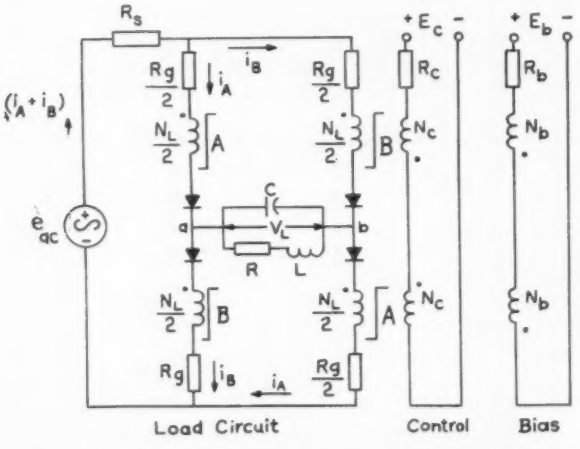

Fig. 1. Half-wave push-pull bridge magnetic servo amplifier.

to support the larger amount of volt–seconds for a given control signal (core *B* for the control signal polarities shown in Fig. 1).

Having additional blocking, or limiter, voltage, the cores can reset at a higher rate and absorb more volt–seconds during the reset half cycle for a given control signal than is possible with a resistive load. (Of particular interest is the situation for maximum control signal.) Consequently, the cores can support more volt–seconds during the following gating half cycle and, thus, provide a higher torque-producing voltage to the motor control winding.

Once the various voltage, current, and volt–second equations for the amplifier and the motor are obtained, the optimum values of the limiting resistor R_s, the quiescent firing angle θ (i.e., the firing angles of both cores when no control signal is applied), and the tuning capacitor C may be determined.

The optimum value of C is that which makes the R–L–C load a maximum impedance at the fundamental frequency.

The optimum value of R_s is defined as the minimum value of R_s which does not result in the firing of core B (for control polarities as shown in Fig. 1) with the application of maximum control signal to the cores. The optimum value of R_s, so defined, results in the maximum torque-producing voltage with the minimum losses in the amplifier for a given motor.

Therefore, the optimum value of R_s is obtained by equating the volt–second change of core B during the reset half cycle to the volt–seconds absorbed by core B during the gating half cycle for the firing angle of core A equal to zero, and the firing angle of core B equal to π. This results in a transcendental equation which may be solved graphically for R_s.

The optimum value of the quiescent firing angle θ is defined as the angle which leads to maximum linearity of the amplifier transfer curve. This angle is obtained if the firing angle of core A and that of core B are equal to zero and π, respectively, for the same control signal.

In order to determine this optimum value, a relationship between the firing angles of cores A and B and θ is established first, based on the requirement that an incremental change in control ampere–turns during the flux resetting half cycle causes equal change in volt–seconds absorbed by cores A and B during the flux gating half cycle. Then by setting the firing angles of cores A and B equal to zero and π, respectively, and solving for θ, the optimum value for θ is determined.

The amplifier–motor characteristic is established by expressing the motor stall torque as function of the firing angle of core A, and then by expressing the firing angle in terms of the control signal.

Even though the derivation of the various equations is at times cumbersome, the results are illuminating and readily applicable to the design of amplifiers.

The results have been verified by experiments, which show a close correlation between the calculated and experimental findings.

Digest of paper 60-784, "Analysis and Optimization of the Bridge Magnetic Servo Amplifier with True Motor Load," recommended by the AIEE Magnetic Amplifiers Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Communication and Electronics*, Sept. 1960.

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High-Voltage Static Eliminators for Teletypewriters

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The presence of static charges on teletypewriter paper tape and rolls may result in delays and jamming. Principles and features of a recently developed static eliminator utilizing a high-voltage discharge are discussed.

HIGHLY unfavorable operating conditions are often created by the depositing of static charges on teletypewriter paper tape and rolls. This phenomenon of static electrification will cause delays and require the attention of operating personnel. Messages can even be lost, as the copy may jam in moving mechanisms and be mutilated. Although radium devices have been employed for a number of years by the Bell System for static control,[1] the increasing number of state laws regulating the use of radioactive substances made it desirable to find some suitable substitution. The operating principles and design features of a static eliminator utilizing a high-voltage discharge will be discussed here.

STATIC FACTORS

IN TELETYPEWRITER EQUIPMENT, paper undergoes a number of pressure contacts with other materials. Such contacts include sensing and punching pins, type pallets, platens, sliding surfaces, and the like. The paper, by some such process, can acquire a charge on its surface. The quantity and decay time of the charge is governed by a number of variable factors. These factors include the paper composition, types of opposing surfaces, relative humidity of the ambient air, moisture content of the paper, and the amount of pressure applied. The influencing factors and the electrostatic phenomenon itself are complex and, for the sake of brevity, this background material will not be covered here. It should be realized, however, that such information is essential for the proper design and evaluation of any static control arrangement. For those desiring more information, references are listed at the conclusion of this article.

THEORY

IF THE AIR surrounding charged material is ionized, then the material can neutralize itself by selecting those charges it needs to balance its surface electrically. This requires that a sufficient number of charges of the opposite polarity be available. One means to accomplish ionization of ambient air is to apply a high voltage between point electrodes and nearby grounded members. Any free electrons at the negative end will be repulsed toward the positive side. Experiments have shown that there are always some free electrons in the air. These electrons may have been produced by the action of light or cosmic rays, or as a result of the collision of molecules. As the electrons are sped through the air, they collide with neutral atoms and displace electrons from the outer ring. These electrons will, in turn, displace others. By the use of alternating voltages, both positive and negative ions can be supplied, since each, in turn, would be repulsed by the discharge points.

Utilizing sharp points greatly reduces the amount of voltage necessary to achieve the beginning of ionization, because the electric field is most intense at narrow points. Although an electric field is always perpendicular to a conductor, it is not necessarily uniform but is a function of the geometrical shape of the conductor and will tend to concentrate in those places where the radius of curvature is least.

APPLICATION

THE STATIC ELIMINATORS have been designed as three separate units:

1. A power unit (Fig. 1) to supply the required voltage at a safe current level.
2. An inductor bar (Fig. 2) for mounting on the model *28* and model *15* page printers.

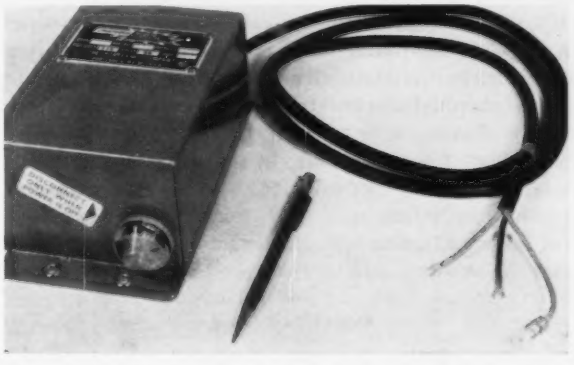

Fig. 1. Power unit.

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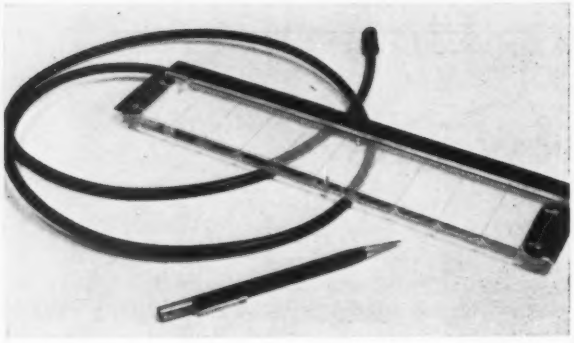

Fig. 2. Inductor bar.

3. An inductor point (Fig. 3) suitable for mounting on the following tape equipment:

a. Model *28* typing reperforator
b. Model *28* reperforator transmitter
c. Model *14* typing reperforator
d. Model *14* reperforator transmitter
e. Model *14* typing unit
f. Model *28* automatic sending–receiving set
g. Model *19* automatic sending–receiving set

POWER UNIT

THE POWER UNIT consists of a 5,000-volt output transformer and a capacitor. These are sealed with a potting compound in a 4- by 6- by 3-inch metal case. The primary is designed for 117 volts, 50 or 60 cycles. A capacitor has been installed in series with one side of the secondary winding to limit the output current to a maximum of 1.4 milliamperes. This side terminates at a duplex outlet on one end of the case. The other side of the secondary is connected to both a ground stud on the case and to the grounding wire of a 3-wire 6-foot power input cord.

The identical power supply is used for both the inductor bar and the inductor point. The duplex outlet provides for simultaneous use of two static eliminators as in the case of the model *19* or *28* automatic sending–receiving sets where it may be required to control static on both tape and page copy. Also, there are installations where a large number of table console models of teletypewriters are installed adjacent to and on top of each other. In such cases, the savings involved in reducing the purchases of power units could be considerable. In the event that only one outlet is used, a plug is supplied as a seal for the unused outlet.

Two flanges with ¼-inch holes can be used for mounting. The unit may be placed on a shelf or fastened to a rack or wall. The only requirement in locating the power unit is that it be within reach of the inductor cable, out of the customer's or maintenance man's way, and in a dry area.

INDUCTOR BAR

PRELIMINARY STUDIES were conducted to determine the quantity of the static charge on teletypewriter page copy and the best location for a static eliminator. By use of an electrostatic voltmeter several charge creating areas in the model *28* teletypewriter were investigated. It was found that at least 70% of the total instrument reading was obtained by the action of the paper being compressed by the rubber platen and almost all of the remaining reading was obtained by the action of the steel type pallet striking the paper. The effects of unrolling the paper, rubbing against the glass and metal edges, and sliding over the dome appear to be negligible. Therefore, it was felt that treating the paper immediately after it left the typing area would be sufficient.

Another requirement was that there be some air space around the section of the paper being treated. If the paper is in contact with any solid surface, both the paper and the contacting body will be neutralized as a whole, but once the paper is parted it will be unbalanced electrically as a separate body.

Because of physical interference, it was necessary to locate the inductor bar in front of the typing unit and under the glass viewing cover. Accordingly, a transparent bar with sharp points was constructed. There are nine recessed discharge points approximately 1 inch apart to give full coverage to the paper. The material used is Plexiglas no. *55*, which has stability and other required qualifications. A wax finish is given in production to afford protection against marring the surface.

Sliding metal brackets are provided at each end of the bar. They are adjusted with the aid of a screwdriver to fit either the model *28* (Fig. 4) or the model *15* teletypewriter page printers. One side of the bracket is painted black to reduce glare to the teletypewriter operators.

A bare wire is stretched along the length of the bar a short distance in back of the points. The wire is bonded to the metal brackets which, in turn, are grounded to the teletypewriter cover when they are installed. Without such a close proximity ground,

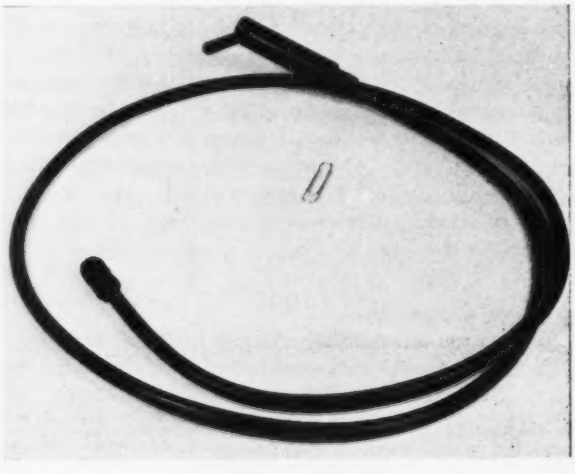

Fig. 3. Inductor point.

the intensity of the electric field would be greatly attenuated and a much higher voltage would have to be employed, probably in the neighborhood of 15,000 volts rather than the present 5,000 volts.[2]

A return path is provided from the proximity ground wire through the frame of the machine to a common ground with the power unit. In most cases the input for the power unit and the teletypewriter will be the same, and this can be used to provide the common ground. If such is not the case, the ground stud on the power unit should be bonded to the teletypewriter frame.

Every point in the bar has its own capacitor. This coupling is utilized to restrict the current further to such an infinitesimal amount that not even a mild shock can be felt by touching the points. Measurements show a maximum current to the inductor bar points of less than 0.05 milliampere.

A rubber-covered high-voltage cable is permanently fastened to one end of the bar and a screw-type connector is fastened at the other end of the cable to permit connection to the power unit. There is some power loss in the cable due to inductive effects, but it was felt that the use of stand-off insulators was an unnecessary complication. To keep this inductive loss to a minimum, however, the cable is restricted to a maximum length of 5 feet.

Tests were carried out in which the distance from the static bar points to a charged web was varied and the resulting voltages measured. They indicated that the optimum distance would appear to be slightly more than an inch. The fact that it is not necessary to be directly adjacent to the paper is an advantage insofar as freedom for locating the neutralizer is concerned.

On the model *15* teletypewriter, the distance from the discharge points to the paper is approximately 1 inch. On the model *28*, the distance is somewhat less. This compromise is necessary because one line of the typed message is obscured due to the nontransparent edge of the inductor bar. By positioning the bar, this line of type is approximately four to five lines above the immediate typing area. It is felt that this would be a very minor objection.

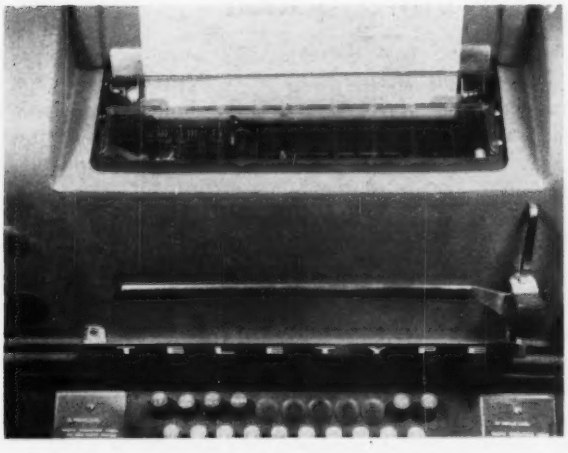

Fig. 4. Inductor bar on model 28 teletypewriter.

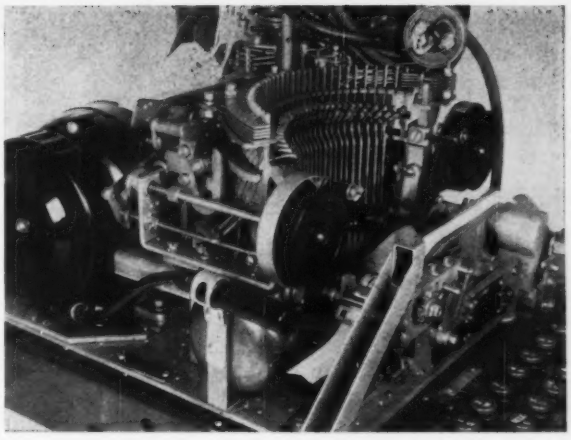

Fig. 5. Inductor point on model 14 typing reperforator.

In field and laboratory trials involving model *28* page printers, static potentials of over 10,000 volts were repeatedly reduced virtually to a zero level by the static bar. How low the actual potential must be kept on teletypewriter paper to avoid difficulties has not been fully determined as yet. Some tests appear to point to a potential gradient below 1,000 volts. There is also the possibility that additional charges might be accumulated in processing after the paper has been neutralized. Therefore, it would be advantageous to have the charge remaining after neutralization as low as possible.

INDUCTOR POINT

THE INDUCTOR POINT consists of a single discharge point mounted at right angles to a coupling capacitor body. As in the case of the bar, the point is recessed. Recessing not only affords protection against scratching of the skin in handling, but also lessens the possibility of arcing due to the point's being too close to a ground. Arcing not only decreases the efficiency of the static eliminators, but also can cause radio interference. The inductor point is made of a highly shock-resistant plastic. This is necessary because of its fairly exposed mounting. A simple 2-piece clamping device is supplied to arrange fastening on any of the tape machines previously listed. It is equipped with a 5-foot inductor cable, as in the case of the inductor bar, to connect to the power unit. No close proximity ground is provided on the inductor point itself, since the teletypewriter equipment is able to perform that function. A common ground with the power unit must be assured as with the inductor bar.

Two of the proposed mounting arrangements for the inductor point are illustrated in Figs. 5 and 6.

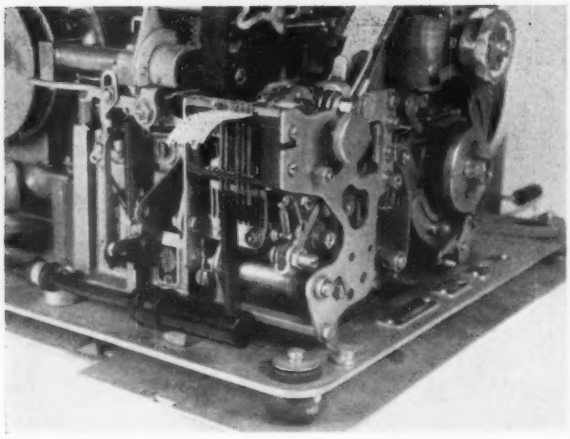

Fig. 6. Inductor point on model 28 typing reperforator.

OZONE AND CORONA

IONIZATION of air is accompanied by the discharge of ozone gas. Ozone has a fresh penetrating odor resembling that of very dilute chlorine. The action is reversible and after a little ozone has been processed it is decomposed at the same rate that it is generated. Ozone can be injurious in high concentrations. The maximum allowable concentration in air is given as 0.1 to 1.0 part per million of air.[3] The inductor bar was tested in the Laboratories with an ozone meter capable of registering amounts far below those of even irritating concentrations. The quantity of ozone liberated by the designed units were so minute as to be undetected on the instrument.

Ionized air at the surface of conductors appears as small tufts and streams visible in the dark. Such ionized air is called corona because of its resemblance to solar corona. With alternating currrent, corona consists of a more or less continuous glow, reddish blue in color. This effect is only visible when in full darkness.

SUMMARY

THE HIGH-VOLTAGE static eliminators, as designed for teletypewriters, have certain distinct advantages. Unlike radioactive elements, they present no safety hazards. The inductor bar, inductor point, and power unit have been approved by Underwriters' Laboratories, Inc., and Canadian Standards Association Laboratory; field tests indicate a high ionizing potential which is sufficient, even in severe static conditions, to reduce the static charge virtually to zero. The units are adaptable for a large number of teletypewriter models and surroundings with a minimum of effort. They can easily be modified for those installations where standard mounting arrangements are not yet available. The equipment has a wide positioning range, so no fine adjustments are required.

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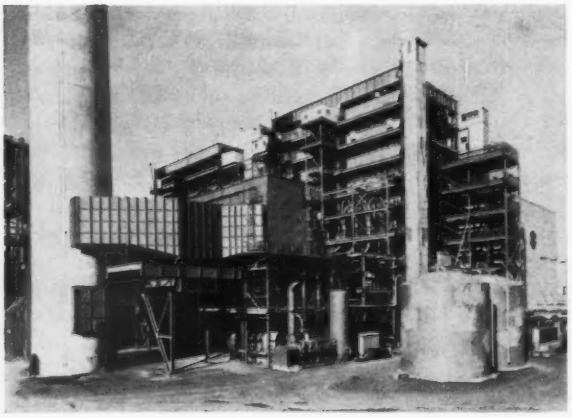
Smoke Control for New Jersey Power Station



Combination mechanical–electrical precipitators for removing 98% of the fly ash from boiler gases have been installed at Ridgefield, N. J., on boilers of the Bergen Generating Station's two 290,000-kw steam turbine–generator units. These units feature virtual duplication of two parallel turbine–generator shafts.

The high-efficiency Cottrell precipitators were designed and built by Research-Cottrell, Inc., Bound Brook, N. J. The $110 million station was recently completed by the Public Service Electric and Gas Company. The precipitators are designed to clean fly ash from 1.8 million cubic feet per minute of combustion gases from both boilers at 300 F. About 4,000 tons of coal are fed to the two boilers each day to produce 3.8 million pounds of steam per hour at 1,100 F.

Airport Apron Outlet Distribution Systems

J. B. CHAPMAN
MEMBER AIEE

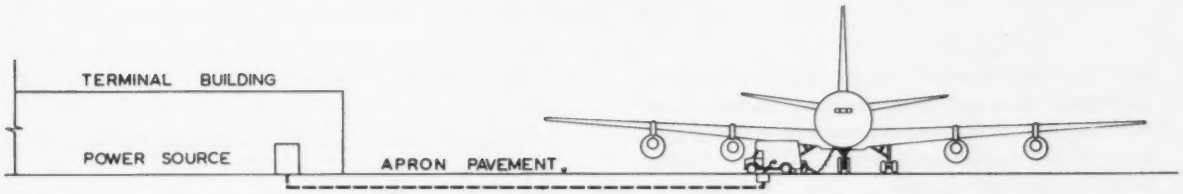


Fig. 1. Supplying electric power to a parked aircraft. The power is transmitted by means of a cable, which is placed in a duct beneath the apron pavement, from the power source in the terminal building to the apron outlet device. A portable cable connects the vehicle, carrying the auxiliary electric apparatus (if required), to the apron outlet device and the aircraft.

TODAY, as never before, existing large commercial airports are undergoing expansion and rehabilitation, and new airports are being designed.

One of the desirable features of the jet-age airport is fixed outlets, adjacent to the parking positions of aircraft on the apron, from which electric power is supplied to aircraft as shown in Fig. 1. The common practice was, and still is at most airports, to obtain power from a mobile combustion-engine-driven generator.

The growth of commercial aircraft ground-power requirements can be traced from the 3-kw of the DC-3, circa 1938, up to the present day turbojet aircraft with requirements of 37.5 to 125 kva, and in some instances a load of 140 kva. Most aircraft electric systems fall into two categories: 28 volts d-c or 115/200 volts, 400 cycles a-c; with the latter representing the current trend in aircraft systems as aircraft become larger and fly higher and faster.

The ground-power requirements of future aircraft are expected to be a function of the gross weight of the aircraft and the square of the indicated air speed of the aircraft.[1]

The systems presently employed to supply power to apron-outlets are:

1. A 50- or 60-cycle motor driving a 115/200-volt 400-cycle generator. This equipment is located in the terminal building.

2. A 380-volt 50-cycle or 480-volt 60-cycle system supplying power to the apron outlet. A motor–generator set or transformer–rectifier converts the normal distribution voltage and frequency to the type of system required by the aircraft.

The maximum capacity of any apron outlet distribution system is primarily limited by the current-carrying capacity of the cable in duct beneath the apron pavement. It is considered that both of the present systems allow little margin for additional load.

A 1,000-volt 400-cycle system has been developed in recent years for use aboard ships of the U.S. Navy.[2,3] By adapting this system to airport use, many advantages would result. The use of a central plant generating 1,000 volts, 400 cycles, rather than the present practice of having many small scattered plants, would result in substantial monetary savings because of the difference in cost per kva between small and large machines at low and high voltages. Less installed capacity would be required because a demand factor could be applied. Maintenance would be less. The mobile vehicle, carrying a transformer and voltage regulator, could be a 3-wheel motor scooter. The kva capacity of cables at this voltage should be sufficient to supply the loads of the next generation of aircraft.

The criterion of any standard is that it be universally applicable. If an airport were to serve only aircraft with d-c electric systems, there would be no need for a 1,000-volt 400-cycle system. However, it is expected that only major airports with heavy traffic will install apron outlets, and that a good percentage of the aircraft they will accommodate will be a-c systems.

It cannot be expected that 1,000 volts, 400 cycles will be a panacea, but it is envisaged that it would be technically and economically preferable in the majority of cases, and very possibly a necessity when supersonic commercial aircraft are a reality.

Further investigations should be made in the pursuit of possibly standardizing airport apron outlet distribution systems at 1,000 volts, 400 cycles.

Digest of paper 60-801, "The Case for Standardizing Airport Apron Outlet Distribution Systems at 1,000 Volts, 400 Cycles," recommended by the AIEE Industrial and Commercial Power Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Power Apparatus and Systems*, Oct. 1960.

J. B. Chapman is with Ammann & Whitney, Athens, Greece.

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The "Bucking Bronco" Motor as a Nonlinear Oscillator

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The "bucking bronco" motor is a "relaxation oscillator." It is part of a nonlinear system, and investigation of it gives insight into many problems in the nonlinear analysis of both electric and mechanical systems. The "bronco" is described from a physical viewpoint, through differential equations, in terms of an equivalent circuit and from an analog computer study.

THE external behavior of the "bronco" has been described elsewhere in terms of the operation of a single motor. The "bronco," however, is part of a system, as shown in the circuit diagram in Fig. 1. The system includes two machines. The driver is a series generator driven at a constant speed. The "bronco" is a separately excited motor with constant excitation and running under no load.

In the following analysis, it will be assumed that the various inductances in the circuit may be treated as a single total constant inductance L and that the total resistance may also be treated as the lumped parameter R. Brush drops, demagnetizing components of armature reaction, and change in inductance due to saturation will be neglected. The voltage generated by the series machine will be called E_g, where $E_g = E_g(i)$. $E_g = E_g(i)$ is a nonlinear function of the current i.

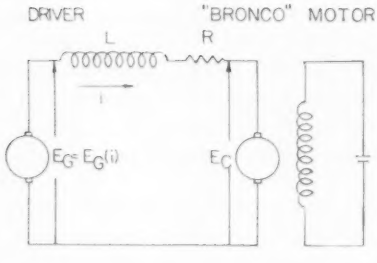

Fig. 1. Circuit diagram for the "bronco" system: (*left*) d-c series machine driven at constant speed; (*right*) d-c separately excited machine with constant excitation.

Under the conditions listed, the motor has a counter voltage E_c which is proportional to ω, the speed of rotation of the motor. Hence

$$E_c = c\omega \tag{1}$$

where c is a constant.

A voltage equilibrium equation around the loop may be written as follows:

$$E_g = L\frac{di}{dt} + Ri + E_c \tag{2}$$

If E_c is determined according to equation 1, equation 2 may be written

$$E_g = L\frac{di}{dt} + Ri + c\omega \tag{3}$$

To determine the behavior of the system, it is necessary to obtain another equation relating i and ω. The energy input per second (power) to the motor is $E_c i$. Since the motor is not driving a load, this energy must be used to accelerate its rotating parts and supply its losses, which include windage and friction. These losses will be neglected. The kinetic energy of the motor is $\frac{1}{2}J\omega^2$ where J is the moment of inertia of the rotating parts. Therefore, from the energy balance consideration

$$E_c i = K\frac{d}{dt}\left(\frac{1}{2}\ J\ \omega^2\right) \tag{4}$$

where K is a conversion factor for units.

Substituting equation 1 in equation 4 and performing the indicated differentiation, with simplification, yields

$$ci = K\ J\frac{d\omega}{dt} \tag{5}$$

Equations 3 and 5 give the necessary two equations relating i and ω.

Fig. 2 shows the functional relationship between E_g and i for positive values of current. If the residual voltage at $i = 0$ is neglected, the function E_g is an odd function of i. It could, therefore, be approximated by an expression of the form

$$E_g = k_1 i - k_3 i^3 \tag{6}$$

where k_1 and k_3 are positive. If it is assumed that $k_3 = 0$, the case of a linear relation between E_g and i is obtained. This special case will be discussed in a following paragraph. The assumed expression for E_g given in equation 6 may be substituted in equation 3 giving

$$k_1 i - k_3 i^3 = L\frac{di}{dt} + Ri + c\omega \tag{7}$$

Equation 7 may be differentiated to give

$$k_1\frac{di}{dt} - 3\ k_3 i^2\frac{di}{dt} = L\frac{d^2\ i}{dt^2} + R\frac{di}{dt} + c\frac{d\omega}{dt} \tag{8}$$

Essentially full text of the paper awarded first prize in the 1959-60 Student Papers Competition of AIEE District 7.

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Appreciation is extended to M. Graham, P. E. Pfeiffer, and J. S. Waters of the faculty for their advice, ideas, encouragement, and help on the preparation of this article. J. H. Cyprus, a fellow student, helped on the design of the photoformer unit described in the article. Thanks are also due to Mrs. John Goodwin for preparing the manuscript and M. K. Oshman, a student, for making the drawings.

Equation 5 may be solved for $\frac{d\omega}{dt}$ and the result substituted in equation 8. Upon rearranging the resulting equation, the following is obtained:

$$L\frac{d^2i}{dt^2} + (R + 3k_3i^2 - k_1)\frac{di}{dt} + \frac{c^2}{KJ}i = 0 \qquad (9)$$

The terms multiplying $\frac{di}{dt}$ in equation 9 represent the damping in the system. If k_1 is large enough, the system will have negative values of damping for small values of i. However, because of the $3k_3i^2$, the damping must become positive as the current increases. The graph of the function relating damping to current is a parabola, symmetrical about $i = 0$ and concave upward. This parabola is shifted vertically as determined by $(R - k_1)$. Fig. 3 shows the conditions mentioned.

If a linear relation between E_g and i is assumed, equation 9 becomes

$$L\frac{d^2i}{dt^2} + (R - k_1)\frac{di}{dt} + \frac{c^2}{KJ}i = 0. \qquad (10)$$

Equation 10 is encountered frequently in the study of electric circuits. It is a second-order linear differential equation with constant coefficients. The relative damping is proportional to $(R - k_1)$. For $(R - k_1) = 0$, the damping is zero and the system response is sinusoidal. For $(R - k_1)$ negative, the system has negative damping and is unstable. This is shown by the fact that the solution has terms which grow exponentially with time.

It should be noted that in the case of an undamped system, from equation 5, the speed must lag the current by $\pi/2$. Equation 5 also shows that in any case the speed must be changing most rapidly at points of maximum current and the speed must have horizontal tangents at points of zero current.

Equation 9 may be normalized by the following substitutions

$$\omega_o^2 = \frac{c^2}{LKJ}$$

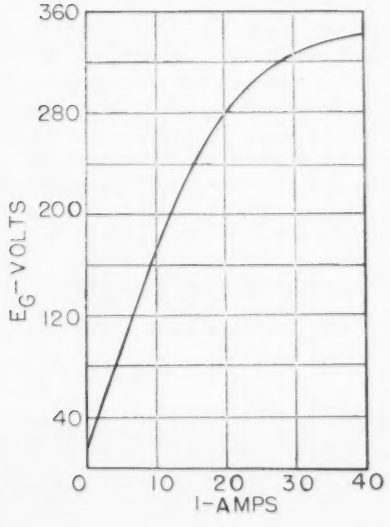

Fig. 2. E vs. I for d-c generator GE 5B284A1698, 230 volts, 19.6 amperes, 1,150 rpm, 5 hp.

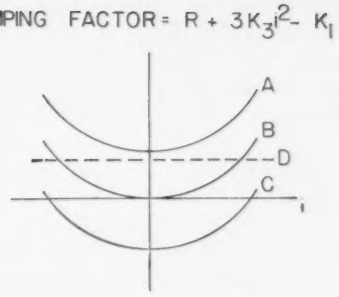

Fig. 3. Damping factor vs. current. A—always positive damping; B—zero damping for $i = 0$; C—negative damping for small values of current; D—constant damping, $k_1 = 0$.

$$t' = \omega_o t$$

$$x = \frac{i}{\sqrt{(k_1 - R)/3k_3}}$$

and

$$\epsilon = \frac{k_1 - R}{L\,\omega_o}$$

These substitutions give

$$\ddot{x} - \epsilon(1 - x^2)\dot{x} + x = 0 \qquad (11)$$

where the dots represent differentiation with respect to t'. Equation 11 may be recognized as the well-known van der Pol equation.

THE EQUIVALENT CIRCUIT

Equation 5 may be integrated to obtain

$$\omega = \frac{c}{KJ}\int i dt. \qquad (12)$$

When equation 12 is substituted in equation 3, the following is obtained:

$$E_g = L\frac{di}{dt} + Ri + \frac{c^2}{KJ}\int i dt. \qquad (13)$$

This leads directly to the equivalent circuit of Fig. 4. The capacitor C is an energy storage element in the equivalent circuit and its role in the electric circuit is identical to the role of the rotating mass J in the mechanical system.

In the preceding section of this paper, the "bronco" was discussed for a particular functional relationship between E_g and i. As the linear portion of the E_g vs. i curve becomes more vertical and the saturated portion becomes more horizontal, the curve of E_g vs. i shown in Fig. 5 may be assumed as a limiting case. This special case takes E_g as $+E$ for i positive and $-E$ for i negative. Such a case is often assumed in analyzing the dynamic behavior of multivibrators and similar electronic circuits. This special case is not differentiable at $i = 0$ and hence the previous mathematical analysis must be modified. The equivalent circuit will be useful in analyzing what would happen for this special case.

Let us assume that the circuit is initially at rest with $i = 0$. Any small disturbance would initiate current flow because the circuit would find itself with a voltage at its terminals. The current would initially increase and then decrease as the capacitor became charged. If

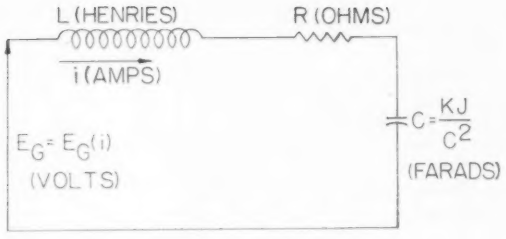

Fig. 4. Equivalent circuit for the "bronco."

the circuit Q is greater than ½, the current would even reverse direction of flow. The instant it reverses direction, the current would find that it has been given a "kick" by the voltage at the terminals of the circuit which reversed sign when current reversed. The process would be repeated and an oscillation would take place. Referred to the physical system, this ideal case pictures the series generator as an automatic switch, reversing the polarity of its voltage as current reverses.

LABORATORY INVESTIGATION OF THE "BRONCO"

THE INDUCTANCE L of the circuit was measured with a General Radio type *650-A* impedance bridge. Hence, the value of inductance was necessarily an unsaturated value. The speed voltage constant c was determined by impressing a voltage on the separately excited motor and measuring the speed. The curve of voltage vs. current for the series generator was taken by loading the generator with different resistive loads and measuring the voltage and current. This curve is given in Fig. 2. For this determination, hysteresis was neglected. The moment of inertia J of the separately excited machine was determined by a retardation test. The largest resistance in the circuit was a water box in series with the two machines. The resistance of the water box was dependent upon the current and its resistance was measured for several values of current. The water box resistance was found to vary from 11.0 ohms for small values of current to 9.4 ohms for large values of current, that is, 30 amperes. The wire resistance, the series field resistance, and the armature resistance add perhaps 1 or 2 ohms, although this number was a difficult one to determine. The total resistance R in the circuit is the sum of the above resistances. The actual value used in the equations could be in error by as much as 25%. The results of the tests follow:

J = 3.38 pound-feet^2
c = 0.1185 volt/rpm = 1.13 volts/radian per second
L = 0.0186 henry
R = 12 ohms

Substitution of these values in equations 3 and 5 gives the following:

$$E_g = 0.0186\frac{di}{dt} + 12\,i + 1.13\,\omega \qquad (14)$$

$$1.13i = \left(\frac{746}{32.2 \times 550}\right) 3.38\frac{d\omega}{dt} = 0.1425\frac{d\omega}{dt} \qquad (15)$$

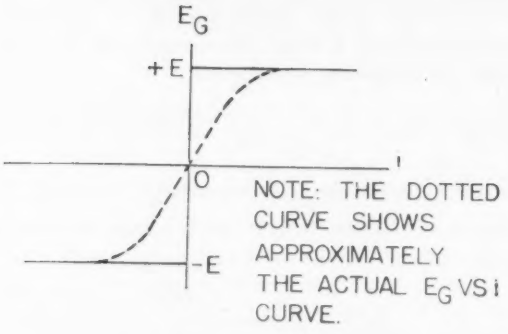

Fig. 5. A special case of E_g vs. i.

The factor K is shown in parentheses in equation 15. For these equations, i is in amperes, ω in radians per second, and E_g is in volts.

The operating curves for the actual system are shown in Fig. 6. The maximum current is 33.6 amperes, the maximum speed is 655 rpm, and the period is 2.7 seconds. From the E_g vs. i curve of Fig. 2, k_1 is found to be approximately 16 ohms by measuring the slope of the linear portion of the curve.

Correlation of the observed behavior with the equations may be noted. $(R - k_1)$ is negative and the system has negative damping for small values of current. As the current increases, the damping becomes positive as can be observed by noting the change in slope of the E_g vs. i curve of Fig. 2.

A PHYSICAL EXPLANATION

A PHYSICAL EXPLANATION of the "bronco's" operation can also be given. Consider the motor to be at rest. Because of the residual magnetic field of the series generator, its voltage builds up and a large current is forced through the circuit. This accelerates the motor. As the speed of the motor increases, it generates an increasing countervoltage and the current in the circuit decreases. This decrease in current decreases the voltage generated by the series generator. Because of the energy stored in the rotating mass of the motor, the motor countervoltage becomes greater than the series generator voltage, current reverses, and the field of the series generator is flashed. Current is now flowing through the series generator in the opposite direction and the motor decelerates. The series generator voltage builds up as the motor slows down. The motor eventually reverses direction of rotation. This operation can be observed in Fig. 6.

ANALOG COMPUTER STUDY OF THE "BRONCO"

EQUATIONS 14 and 15 may be rearranged to the following:

$$\frac{di}{dt} = 53.8\,E_g - 646\,i - 60.8\,\omega \qquad (16)$$

$$\frac{d\omega}{dt} = 7.94\,i \qquad (17)$$

Appropriate scaling factors may be introduced and then equations 16 and 17 may be transferred readily to a block diagram for a computer study. An additional problem is present because of the nonlinear relationship between E_g and i. A nonlinear function generator of the photoformer type was constructed by the author and a fellow student. Hysteresis was necessarily neglected.

The curves from the computer study are given in Fig. 7. The maximum current was 27.6 amperes, the maximum speed was 475 rpm, and the period was 1.2 seconds. The system parameters were varied on the computer about the experimentally determined values and it was found that the resistance R was the most critical parameter. The computer curves are of the same shape as the actual operating curves, although there are considerable discrepancies in the period and the maximum response values.

CONCLUSIONS

An attempt has been made to present a study of a particular nonlinear problem from several points of view. The differential equations were studied, an equivalent circuit was presented, the physical system was investigated, and an analog computer study was performed.

The computer study indicated that the resistance R was the most critical parameter. This should be expected from consideration of equation 9 and also the equivalent circuit. As previously mentioned, $(R - k_1)$ determines the degree of negative damping for small values of current. The fact that a difference is involved makes the determination of R very important. The importance of R can also be seen from consideration of the equivalent circuit. R is important in the determination of the circuit Q which in turn is a measure of the tendency for the current to reverse direction. This fact was pointed out in the discussion of the equivalent circuit. It is unfortunate that the laboratory measurement of the parameter R was perhaps the least accurate of all the laboratory determinations.

A number of simplifying assumptions were made in reducing the physical system to a working model. These assumptions should certainly not be treated lightly when correlating theoretical results with actual results. The computer study should be viewed as an investigation of the model. For example, the inductance of the actual circuit is certainly not constant but varies with current. For the computer study, the inductance was treated as a constant.

Nonlinear systems are the rule and not the exception in physical phenomena. Because of the mathematical difficulty encountered in nonlinear analysis, linear approximations to nonlinear systems are often made to facilitate their study. While the linear approximations are often very satisfactory, they frequently fail to describe systems which depend primarily on nonlinear characteristics for their operation. The need in engineering of more exact mathematical models of physical systems leads invariably to the nonlinear approach with the inherent difficulties of such analysis. The exact mathematical formulation becomes cumbersome, and the need of supplementing the exact with an approximate mathematical formulation is evident. In studying the "bronco," the straightforward analysis was supplemented by physical reasoning, an equivalent circuit, an analog computer study, and mathematical approximations. Each of these approaches contributed individually to an understanding of the dynamic behavior of the system and collectively supplemented each other in aiding the author to arrive at a suitable explanation of the workings of the system. The "bronco" is an example of an important class of nonlinear systems, and its study from a variety of viewpoints has provided straight insight into other nonlinear problems and their analysis.

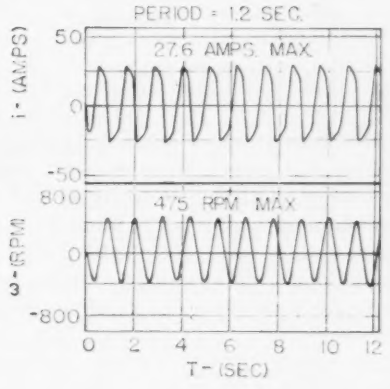

Fig. 7. Computer curve giving transient and steady-state current and motor speed vs. time.

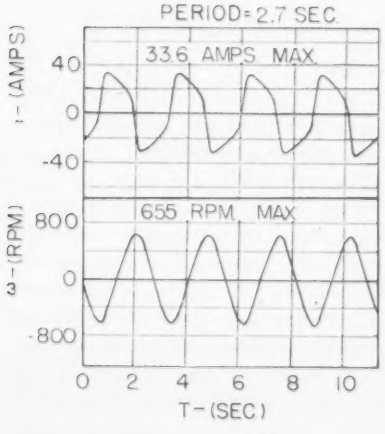

Fig. 6. Operating curves showing transient and steady-state current and motor speed vs. time.

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Servo Control for Synchronized Conveyors

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The electric controls for a conveyor system used in the automotive industry are described. Although the material presented relates to a particular type of conveyor system, many features of the control system may be used in other applications.

ASSEMBLY-LINE conveyors have been in general use for many years, particularly in the automotive industry. Many plants have conveyor systems several miles in length. Since there are many disadvantages in having one single conveyor of this length, the production lines consist of a number of short conveyors. Until recent years, the method used for transferring production units from one conveyor to another was to manually push the units, which are mounted on dollies, from one conveyor to the next. This operation required many man-hour units of labor. The problem, therefore, was to reduce this manual material handling by automatically transferring the production units.

DESCRIPTION

AUTOMOTIVE-BODY CONVEYORS are of the floor type and are driven by d-c motors. Automobile bodies are

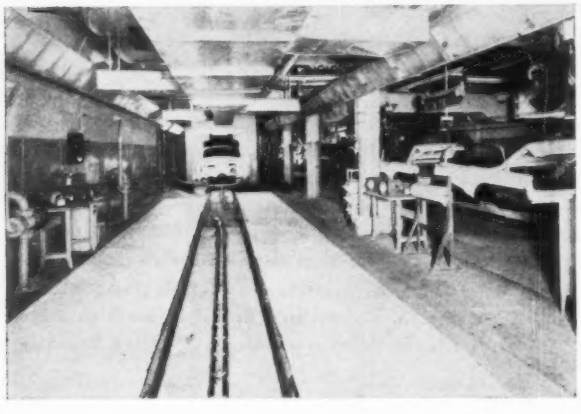

Fig. 1. View of conveyor transfer area.

mounted on special dollies and pulled along by conveyor dogs as shown in Figs. 1 and 2. The dogs are

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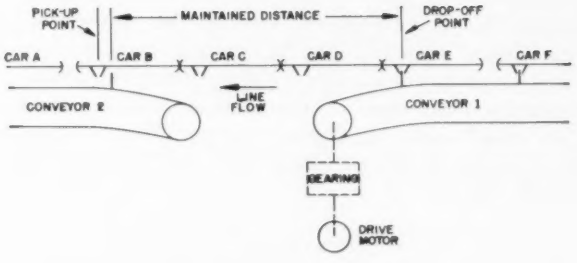

Fig. 2. Conveyor transfer area.

spaced approximately 16 to 18 feet apart along the conveyor chain. Fig. 2 shows several bodies in various degrees of transfer. The bodies are traveling from right to left as indicated. Car *A* has already been transferred. Car *B* has reached the proper position so it can be picked up by a dog on conveyor *1*. It has reached this position as a result of car *C* pushing it across the transfer area. Car *C* has been advanced to its present position by car *D*, and car *D*, in turn, by car *E*. Car *E* has reached a point where the dog on conveyor *1* will disengage from the dolly frame and it will temporarily stop. As Car *F* continues to advance, it will bump the rear of the dolly frame of car *E* and push cars *E*, *D*, and *C* ahead. Prior to this operation, however, car *B* is picked up by conveyor *2* and leaves the group of cars in the transfer area.

In order to effect a smooth transfer of units, it is important to maintain the relative position of the dogs on the adjacent conveyor. If conveyor *1* gets too far behind, conveyor *2* will fail to pick up a body and a void will occur on the line. If conveyor *1* gets too far ahead, bodies will begin to pile up in the transfer area and possible damage could result. Adjacent conveyors, therefore, must be synchronized to maintain the dog spacing between conveyors.

Since each conveyor has its own drive and control, the description that follows will cover the electric equipment for one conveyor, similar to conveyor *1* in Fig. 2, and its relationship with conveyor *2*.

Each conveyor is driven by one or often several identical d-c motors in an adjustable voltage system as shown in Fig. 3. One common d-c generator is used regardless of the number of motor drives. The conveyor configuration and length are determining factors in the number and location of the separate motor drives. Means are provided to adjust each individual motor so each can assume its proper share of the total conveyor load. Each

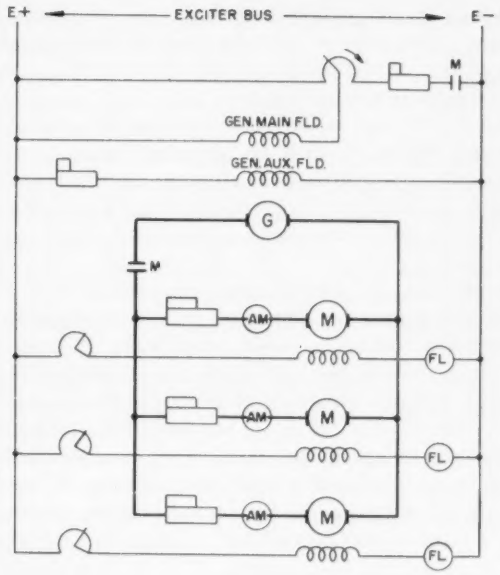

Fig. 3. Adjustable-voltage systems with manual speed control.

motor is protected for thermal and instantaneous overloads and for loss of field. Load ammeters are provided to detect load changes in the different drives which may develop as the result of conveyor wear or minor mechanical disturbances. These slight variations can readily be detected, therefore, and corrective action taken.

The adjustable voltage d-c generator is used to control the motors over a 6-to-1 speed range. This generator has two shunt fields: an auxiliary shunt field for bucking out the residual voltage of the generator and the main control shunt field. The excitation for the generator and motor fields is supplied by a d-c exciter. The exciter supply is a separate unit and is designed to handle the d-c control requirements for all conveyors in the line.

Fig. 3 shows manual control of the main generator shunt field. Manual operation is provided on all conveyor controls, as an alternate method of operation, in case the automatic controls for synchronizing conveyors should fail. During automatic operation, however, the generator main shunt field is transferred and energized by the regulating system.

Speed Regulator. Fig. 4 illustrates the basic counter-emf speed regulator which sometimes is called a generator voltage regulator. It is a single-phase full-bridge self-saturating type magnetic amplifier regulator. This type of regulator was selected over other varieties because it offers a number of features very desirable for this application. It is a completely static type regulator, very rugged and reliable with long life. The regulator is a single-stage unit and its output controls the excitation to the generator main shunt field in proportion to the desired speed. The bias winding is used to precondition the amplifier and is adjusted for minimum magnetic amplifier output with no other signals in the other control windings. An ampere-turns matching system is used to compare signals; therefore, all input signals are isolated from one another. In this system, the ampere-turns of the reference winding are compared to the ampere-turns of the feedback winding. The difference in the number of ampere-turns determines the magnetic amplifier output. Positive ampere-turns are supplied by the reference winding, which is adjustable for different speeds by the setting of the manual speed-adjusting rheostat. Negative ampere-turns are supplied by the feedback winding, which obtains its signal from the generator output voltage. Since the load variations on the conveyor are small, no IR compensation is required. During normal operation, the reference speed signal is preset and time rate acceleration, not shown in Fig. 4, is used to protect the rotating equipment. Without time rate acceleration or other types of limiting devices, the regulator would force the generator voltage to the correct value too quickly and the armature current would be excessive.

The speed regulator, as described, alone will not maintain the correct dog spacing between conveyors. It only attempts to match the speed of the two conveyors approximately. An additional winding on the speed regulator, called the position compensation winding, is used to correct any errors in the position of the relative conveyor dogs. Its signal, in effect, adds or subtracts from the effect of the reference winding and results in an increase or decrease in speed to correct the error.

Position Compensation. A synchro system, shown in

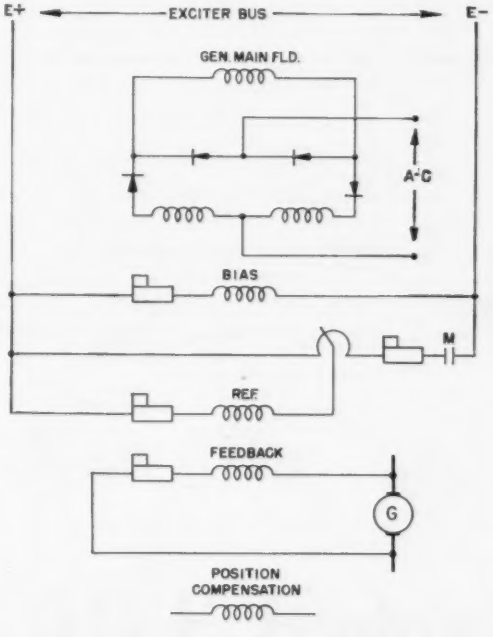

Fig. 4. Single-stage counter-emf speed regulator

Fig. 5, is used to detect relative dog position. The shaft of a synchro transmitter is geared to the lead conveyor to make one revolution for each dog or car spacing. Likewise, a synchro differential transmitter is geared to the conveyor being controlled. The shafts of both of these units are arranged to pass through the rotor position known as "electrical zero" at the same time, if the relative position of the dogs on the two conveyors is correct. The synchro control transformer has its rotor shaft locked in the electrical zero position and its output signal is zero when the rotor shafts of the transmitter and differential transmitter have the correct relationship. If conveyor *A* lags behind conveyor *B*, the control transformer will provide an output voltage of a certain polarity and a magnitude which depends on the amount of error. If conveyor *A* leads conveyor *B* in relative position, the output voltage signal of the control transformer will have the opposite polarity and again a magnitude which depends on the amount of error. Since the output of the control transformer is an a-c signal, it is necessary to demodulate this signal. A phase-sensitive detector is used to obtain a direct voltage not only proportional to the alternating voltage impressed upon it but also having a polarity dependent upon the polarity of the alternating voltage signal. A simple static phase-sensitive detector is shown in Fig. 5 and operates in the following manner. A supply voltage, which originates from the same source as the voltage for the synchro system, is used as a reference. The a-c output of the control transformer is applied to the input of the network. When the input signal is zero the output signal is also zero, because the voltages appearing across the two resistors are equal and opposite in polarity. When the input or error signal of a certain polarity is present, it will add to the reference voltage for one half-wave circuit and subtract from the reference in the other. This results in unequal voltages across the two resistors and an output signal from the detector which will be proportional to the input a-c signal. If the input signal voltage is of the opposite polarity, the action of the two half-wave circuits is reversed and the output signal is also reversed.

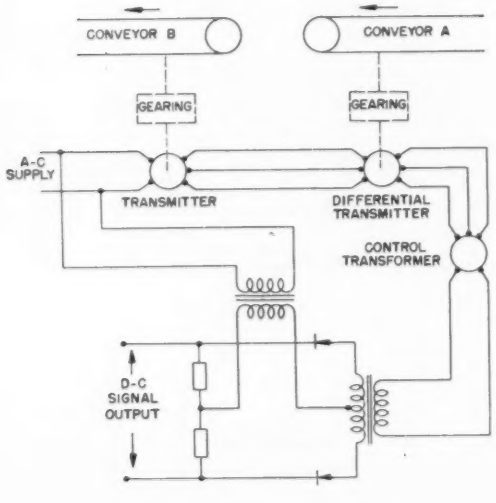

Fig. 5. Position phase-sensitive detector.

Since the output of the phase-sensitive detector is a low-energy signal, it must be amplified before it can be used as an input to the magnetic amplifier speed regulator. A push-pull magnetic amplifier was used for this purpose and it also serves to limit the effectiveness of the error signal.

The effect of the position compensation winding on the speed regulator was designed to vary the speed of the drive approximately $\pm 15\%$ maximum. This maximum correction is obtained when the controlled conveyor is 1 inch out of step or, in synchro terms, approximately 1.6 degrees error. The push-pull magnetic amplifier was designed, therefore, to produce maximum output in each direction with this amount of error. Larger error signals from the phase sensitive detector will not produce more than a 15% change in corrective speed.

Position compensation was also designed to be 15% effective at any speed in the speed range. The taper potentiometer connected across the output of the push-pull magnetic amplifier is coupled to the reference potentiometer of the speed regulator and they are varied together. This feature is desirable to prevent the position compensation from becoming too effective at low speeds and causing wide fluctuations in the conveyor speed.

Interlocking and Limit Control. The speed-regulating system was designed to regulate the position of adjacent conveyor dogs ± 1 inch during normal operation of the conveyors. However, one conveyor in a cascaded system may occasionally be stopped for a brief period and then restarted. This conveyor down time is usually the result of minor manufacturing difficulties which may occur from time to time. The system could be interlocked to stop all conveyor drives automatically when any one conveyor is stopped. However, this down time in most cases is less than 10 seconds and adjacent conveyors can be run for short periods without causing any damage. It is, therefore, highly desirable to keep each conveyor running as long as possible and eliminate extra stopping and starting operations. However, the control still must prevent faulty transfers and protect both the conveyor and production units from damage.

The usual spacing between the rear of one body to the front of the next is approximately 1 foot. This spacing, shown in Fig. 2, is necessary so that bodies can be pulled around corners freely. Fig. 2 shows car *B* has advanced to its pick-up point, since car *E* has reached its drop-off point (the point where the dog disengages from the body dolly). It is to be noted that if conveyor *1* were stopped in its present position, conveyor *2* could continue to run and pick up car *B* without causing any trouble. If, however, car *B* had not advanced to a position where the dog on conveyor *2*

could pick it up, conveyor *2* must be stopped within reasonable limits so it will still pick up a unit when conveyor *1* restarts. It is possible to allow a conveyor to run ahead sometimes as much as 11 inches before it is necessary to stop it.

The purpose of the position limit control, therefore, is to prevent the two related conveyors from getting out of position. Each position limit control consists of two relays that furnish contacts for interlocking in the main conveyor control circuits. The *CS* (conveyor slow) relay functions when conveyor *1* gets behind conveyor *2* and its contacts are tied in with the control for conveyor *2* to stop it. The *CF* (conveyor fast) relay functions when conveyor *1* gets too far ahead of conveyor *2* and its contacts are tied into the main control circuits of conveyor *1* to stop its own drive.

The limit control utilizes the output of the phase-sensitive detector to control magnetic-type static switching units as shown in Fig. 6. One static switching unit is used to control each of the two relays. Each circuit is designed to have its relays energized when the conveyors are in position and de-energized when the conveyors are not in position. This type of operation provides a fail-safe feature should the a-c supply fail or a relay become inoperative. The position limit control is adjustable for any error between 0 and 11 inches by the adjustable bias circuit.

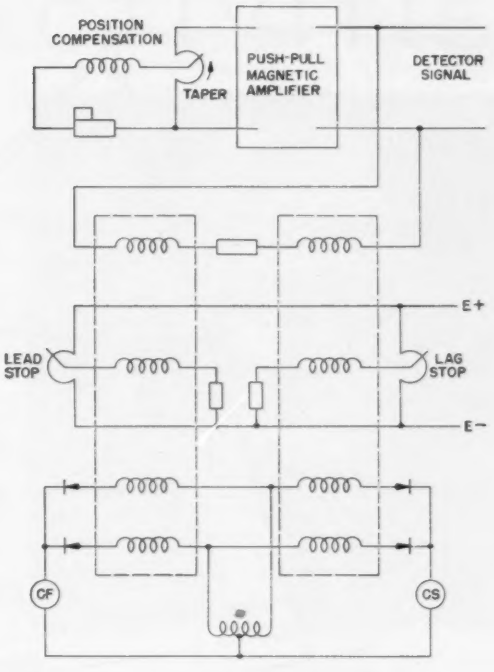

Fig. 6. Position compensator and limit control

Master Speed Control. On automotive production lines, it is essential that the production rate be adjustable and, once adjusted, maintained at a contant value. One conveyor in a line must be the pace setter or master for the entire conveyor system. A master conveyor, therefore, functions to maintain speeds, not dog position. On a master conveyor the synchro transmitter is geared to a master speed control unit which consists of a synchronous motor and adjustable gear unit. This special gear unit has indicating dials which rotate with the gear settings. The dials are calibrated to indicate the production rate in units per hour. Changing dial settings on the gear unit automatically changes the gearing of the master speed control unit and the speed of the synchro transmitter.

Special Features. In the automotive industry, every effort must be made to maintain production. Any interruption in production because of mechanical or electrical failures is a very serious matter. Each minute of down time results in lost production worth many hundreds of dollars. This is one of the main reasons why reliable magnetic amplifiers were used in the regulating system and also the reason provisions were made for manual operation. The same idea is carried through on all the other parts of the control system. Any failures in the electric control system or mechanical parts of the conveyor must be detected and corrected quickly. For this reason, an elaborate indicating system is provided to aid both the production and maintenance people to find their respective sources of trouble. Thus,

1. Every control relay, start–stop push button, limit switch, or any other function directly involved in the control of the conveyor has a light to indicate its operation.

2. Voltmeters are provided to measure generator output voltage and exciter voltage.

3. Ammeters are furnished in the armature circuits of all drive motors.

4. An indicating synchro is used to detect position errors between adjacent conveyors.

The system also includes bypass and fused circuits to facilitate minor repairs without shutting down the line or working on hot circuits.

CONCLUSIONS

THE CONVEYOR electric system described is another illustration of the benefits of automation. The man-hour savings in eliminating manual transfer operations alone will pay the cost of the electric system within a year. Other advantages are reduced conveyor down time, increased production, and lower costs.

Wear Your AIEE Badge

TWO OUT OF FIVE AIEE MEMBERS have contributed to the United Engineering Center. Three out of five will finish the job. How about you?

INSTITUTE ACTIVITIES

President's Message

C. H. LINDER
PRESIDENT AIEE

Our newly elected president discusses three objectives toward which the Institute must work if it is to become more meaningful to a growing membership in a period of great expansion in science and technology.

AT the foundation of the AIEE its objectives were declared to be: exchange of knowledge and experience among engineers, help and guidance to engineering education, and the fostering of the engineer's professional stature. The events of history since these objectives were enunciated have underscored the validity of all three. They should serve well, then, as the basis for general appraisal and specific plans by the newly elected officers of the Institute.

History has not, however, dealt with each objective in the same way. History—especially recent history—has pushed forward the particular objective of professional information exchange into great prominence. Not only have we experienced great growth and change in science and technology, but the rate of acceleration is also increasing.

The results have been only what should be expected. In order for the engineer to make his unique contribution of applying knowledge and understanding for practical use by society, the classic disciplines have had to divide and subdivide almost by fission. Naturally, groups bound together by intense interest in specialized technologies have proliferated—together with all the paraphernalia of organization, including meetings and publications.

Just as naturally, there is developing a pattern of "combined approaches" to meet the need for exchange of professional information and experience. I have in mind two patterns of growing familiarity. In one, programs are developed around the broad spectrum of technological needs of a particular industry group, such as the electric power industry, or the petroleum industry, or the rubber industry. In the other pattern, progams are developed around a particular technology—semiconductors, for example—and a broad spectrum of those interested in its development and application is embraced. Such specially tailored "draw-offs" from the funds of science and technology are more than inevitable; they are much to be desired and encouraged for their cross-fertilization effects. They are the means by which the original force of the societies' attack upon barrier problems is carried forward in terms of the present and the future.

In the context, then, of this great dominance by change and growth and increasing need for effective exchange of science and technology, I will ask that we work together toward three objectives:

1. A realistic gain in value of the Institute to a growing membership. This will, of course, require continuing and skillful examination of objectives, and detailed guidance of activities. To cite one specific example, we should increasingly encourage in our own meetings and publications more attention to leading-edge subjects. We must lead—not simply record—the acquisition of new knowledge and understanding.

2. Enhanced efficiency in the conduct of the Institute's affairs. Here we have for a basis an excellent headquarters organization plan. We should also go on to examine and modify the mechanisms by which we conduct work projects—with particular attention to tapping the great competence resources in the membership.

3. Increased interest by members in intersociety relationships.

With regard to the third objective, I regard it as the key to eventual unity among the societies. We have already in hand the concepts of the Functional Plan and

C. H. Linder is vice-president and group executive, Electric Utility Group, General Electric Company, New York, N. Y.

the Report of the Special Subcommittee on AIEE-IRE (Institute of Radio Engineers). What we need from here on, I think, is a twofold emphasis on unity. I firmly believe that unity which has meaning in *fact* will come before unity in *form*. It will come—is coming now—among practicing engineers precisely because of this great urgency to bring all relevant knowledge and experience to bear at the frontiers of progress irrespective of traditional boundaries. In this view, unity will be built upward from the grass roots by means of inter-society and cross-discipline exchange of technology. In this view, the point of greatest return will be expenditure of effort to stimulate understanding and co-operation among individual engineers of all affiliations—from the Student Branches through the Sections, and so on through industry, education, and Government. With this effort being vigorously prosecuted, Society officers at the national level will experience the right pressures and practical guidance in their efforts toward formal unification.

It is along these lines, so excellently laid down by those who have preceded us in the roster of officers, that I would see the Institute move. I believe that moving so will take us, within our Society, closer to riding the crest of the exciting waves of change, rather than being tossed about by those waves. I believe that, outside our Society, we must move toward unity in every way which will realize any or all of the Institute's objectives more fully and quickly than can the AIEE alone. I believe that this sort of program has extraordinary potential in the next 2 or 3 years for making AIEE steadily more meaningful to a growing membership.

Aero-Space Problems Are Featured at 1960 AIEE Pacific General Meeting

SAN DIEGO was host to the AIEE Pacific General Meeting and Aero-Space Transportation Conference held August 8-12, 1960, in the El Cortez Hotel. A well-arranged program comprised of 172 papers, many of which explored the barriers of outer space, was combined with two luncheons, a dinner and theater party, harbor cruise and Hawaiian luau, and a banquet and dinner dance, as well as inspection trips to the nearby industries. Twenty committees met during the 4 days of the meeting, and a busy program for the visiting ladies was arranged by Mrs. M. R. Marston, chairman of the Ladies Entertainment Committee. More than 850 members and guests attended the meeting.

The stage was set for the AIEE program to follow by an address, "Space World of Tomorrow," given at Tuesday's luncheon by K. J. Bossart, technical director, Convair-Astronautics, Division of General Dynamics Corporation. The speaker reviewed the reasons for the intensified aero-space activity since the advent of Sputnik I. Attention was drawn to the number of problems yet to be solved, and in conclusion, the benefits to be derived from the conquest of outer space were analyzed.

The challenge which Mr. Bossart presented to electrical engineers was as follows: For travel in outer space, higher exhaust velocities would be required to obtain the necessary thrust which is now of the order of 12,000 feet per second by chemical propulsion. Nuclear energy feeding hydrogen gas passing through a reactor might be the answer to increasing exhaust velocities to 25,000 feet per second. Theoretically, at the present state of the art, to get a 30,000-foot-per-second exhaust velocity would require 250 kilowatts for every pound of thrust produced. To date, power generating equipment weighs 50 pounds per kilowatt; so to obtain 250 kilowatts would require 12,500 pounds for every pound of thrust. Aero-space people are, therefore, relying on the genius of electrical engineers to bring the weight ratio way down to something less than 10 pounds per kilowatt.

DISTRICT 8 Vice-President G. T. Harness (*right*) greets D. H. Scott, chairman of the Aero-Space Transportation Committee, which arranged the aero-space program.
Tally Photography

NASA Program Cited

While predictions are always hazardous, the speaker cited the program of the National Aeronautics and Space Administration (NASA) as recently announced by Dr. Keith Black. An expenditure of some $15 billion will be required for the next decade during which the NASA is planning no fewer than 260 space launches. Man is expected to go in orbit on the first astronautical flight in 1961. Instrumented probes of Mars and Venus are expected in 1962 and circumnavigation of the moon by an unmanned probe, in 1964. The first flight of a nuclear second-stage missile is expected to take place in 1965, and a program leading to man's circumnavigation is expected to start about 1965-67. A moon landing by man will probably occur sometime after 1970. Before man ventures into outer space, much more has to be known about the nature and intensity of various types of radiation and the intensity coming from solar flare which was only recently discovered to be quite an obstacle to overcome in space flight. Meteorite dust must be investigated, and distances between the planets must be known more accurately. Just 1-foot-per-second error in velocity would make a difference of thousands of miles in a flight to Mars; yet the velocity of the earth around the sun was not known within some 35 feet per second.

As to benefits to be derived from investigation of outer space, the advances in technology necessary to attain the results would probably be the greatest benefit. Further study of the ionosphere, the solar spectrum, and a search for planets which may exist around other stars without interference from the earth's atmosphere may be a great boon to the astrophysicists.

The speaker is a well known authority in aero-space problems, who has received

(Continued on p. 840)

AIEE Future Meetings

ECPD 28th Annual Meeting
Queen Elizabeth Hotel
Montreal, Que., Canada
October 3-4, 1960

Fall General Meeting*
Morrison Hotel
Chicago, Ill.
October 9-14, 1960

AIEE-IRE-IIT-NU-IU National Electronics Conference*
Sherman Hotel
Chicago, Ill.
October 10-12, 1960

Nonlinear Magnetics and Magnetic Amplifier Conference*
Bellevue-Stratford Hotel
Philadelphia, Pa.
October 26-28, 1960

AIEE-IRE-ISA Electrical Techniques in Medicine and Biology Conference*
Sheraton Park Hotel
Washington, D. C.
October 31—November 2, 1960

Western Appliance Technical Conference*
Biltmore Hotel
Los Angeles, Calif.
November 7, 1960

Power Industry Computer Application Conference*
Chase Hotel
St. Louis, Mo.
November 9-11, 1960

Fall Textile Conference*
Sir Walter Hotel
Raleigh, N. C.
November 10-11, 1960

AIEE-AIP Magnetism and Magnetic Materials Conference*
Hotel New Yorker
New York, N. Y.
November 14-17, 1960

AIEE-NEMA Electrical Insulation Conference*
Conrad Hilton Hotel
Chicago, Ill.
December 5-8, 1960

AIEE-IRE-ACM Eastern Joint Computer Conference
Hotel New Yorker
New York, N. Y.
December 11-14, 1960
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Oct. 7)

AIEE-IRE-ASQC-EIA Reliability & Quality Control Conference
Bellevue-Stratford Hotel
January 9-11, 1961
(Final date for †TP—Oct. 11, ‡CP Syn.—Oct. 25, CPMs—Nov. 4)

Winter General Meeting
Hotel Statler
New York, N. Y.
January 29-February 3, 1961
(Final date for †TP—Oct. 31, ‡CP Syn.—Nov 10, CPMs—Nov. 25)

AIEE-IRE-U of P International Solid-State Circuits Conference
Philadelphia, Pa.
February 15-17, 1961
(Final date for †TP—Nov. 17, ‡CP Syn.—Dec. 2, CPMs—Dec. 12)

South East District Meeting
Jung Hotel
New Orleans, La.
April 5-7, 1961
(Final date for †TP—Jan. 5, CPMs —Jan. 30)

Materials Handling Conference
Chicago, Ill.
April 11-12, 1961
(Final date for †TP—Jan. 11, ‡CP Syn.—Jan. 26, CPMs—Feb. 6)

Electric Heating Conference
Sheraton-Lincoln Hotel
Indianapolis, Ind.
April 11-12, 1961
(Final date for †TP—Jan. 11, ‡CP Syn.—Jan. 26, CPMs—Feb. 6)

Cement Industry Conference
Sheraton-Cadillac Hotel
Detroit, Mich.
April 18-20, 1961
(Final date for †TP—Jan. 18, ‡CP Syn.—Feb. 2, CPMs—Feb. 13)

Great Lakes District Meeting
Hotel Pick-Nicolett
Minneapolis, Minn.
April 19-21, 1961
(Final date for †TP—Jan. 19, CPMs —Feb. 13)

Rural Electrification Conference
Kentucky Hotel
Louisville, Ky.
May 1-2, 1961
(Final date for †TP—Jan. 31, ‡CP Syn.—Feb. 15, CPMs—Feb. 24)

AIEE-IRE-ACM Western Joint Computer Conference
Ambassador Hotel
Los Angeles, Calif.
May 9-11, 1961
(Final date for †TP—Feb. 8, ‡CP Syn.—Feb. 23, CPMs—Mar. 6)

AIEE-IRE-EIA-WCEMA Electronic Components Conference
May 9-11, 1961
(Final date for †TP—Feb. 8, ‡CP Syn.—Feb. 23, CPMs—Mar. 6)

North Eastern District Meeting
Statler Hotel
Hartford, Conn.
May 17-19, 1961
(Final date for †TP—Feb. 16, CPMs —Mar. 13)

AIEE-IRE Globe-Communication V Conference
Chicago, Ill.
May 22-24, 1961
(Final date for †TP—Feb. 21, ‡CP Syn.—Mar. 8, CPMs—Mar. 17)

Fractional Horsepower Motors Conference
Biltmore Hotel
Dayton, Ohio
May 23, 1961
(Final date for †TP—Feb. 22, ‡CP Syn.—Mar. 9, CPMs—Mar. 20)

Summer General Meeting
Cornell University
Ithaca, N. Y.
June 18-23, 1961
(Final date for †TP—Mar. 20, ‡CP Syn. May 30, CPMs—Apr. 14)

Aero-Space Transportation Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
June 26-30, 1961
(Final date for †TP—Mar. 28, ‡CP Syn.—Apr. 12, CPMs—Apr. 21)

Pacific General Meeting
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961
(Final date for †TP—May 25, ‡CP Syn.—June 5, CPMs—June 19)

AIEE-ASME Engineering Management Conference
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961
(Final date for †TP—June 16, ‡CP Syn.—June 30, CPMs—July 11)

Petroleum Industry Conference
Jung Hotel
New Orleans, La.
September 17-20, 1961
(Final date for †TP—June 19, ‡CP Syn.—July 5, CPMs—July 14)

AIEE-IRE Industrial Electronics Conference
September 20-21, 1961
(Final date for †TP—June 22, ‡CP Syn.—July 7, CPMs—July 17)

Fall General Meeting
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961
(Final date for †TP—June 14, ‡CP Syn.—July 27, CPMs—Aug. 11)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Author's Guide*.
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(Continued from p. 838)

many distinguished awards for his contribution to the development of the Atlas missile and its predecessor, the MX 774 Research Rocket. He received an M.S. degree in 1927 in aeronautical engineering from the Massachusetts Institute of Technology.

President Linder's Remarks

The luncheon was addressed by President Linder, who complimented the committee on the well-arranged program and drew attention to the fact that the papers were probing some of the outer space barrier problems as well as the older problems. Attention was drawn to a three-point program toward which the Institute must work if it is to become meaningful to a growing membership in a period of great expansion in science and technology. President Linder's message appears in full on pp. 837-38.

The luncheon meeting was opened by L. R. Knerr, chairman of the San Diego Section, who introduced the speakers, officers, and past-presidents.

Friday Luncheon

The feature of the luncheon at the close of the meeting was an address by Dr. Kenneth McFarland through the courtesy of General Motors. Dr. McFarland, an inspirational speaker with faith in the spoken word, drew attention to many of the ills that exist in society today. As an illustration of lack of concern in our complex life, the speaker described a talk with a milkman who had no concern other than to deliver the milk, to go fishing in the summer, and bowling in the winter. The more information he received, the more confused he would become, and he did not expect many of today's pressing problems to be solved in a lifetime. In a democracy today, too many people have too little concern about the problems which affect them directly or indirectly.

In respect to the lack of morality today, the speaker cited the philosophy of Georgia Brown, a school teacher in Kansas, who compared the steps taken in early education to climbing the rungs of a ladder; but today, there are many people—the farmers, organized labor, and school teachers—who want to pull the ladders down. If one does not believe that some people should be paid more than others, then they do not believe in the free private enterprise system. In a democracy, the welfare of the majority must prevail.

In regard to the situation in Little Rock, the speaker explained that the action of the nine students, who insisted on going to a certain school when they actually had a better school nearer to their homes, locked out 3,500 white students for a period of time. This was the result of a minority action.

In respect to a hard money policy, the speaker pointed out that the international exchange value of the dollar had not changed since 1952, and that there were only two other countries besides the United States today with a tight money policy where industrial loans could be obtained at a 4% interest rate. In countries with a loose money policy, such as Italy, the interest rate on industrial loans is 12%.

In the matter of international affairs, Dr. McFarland believed that this country was not using its best weapon—moral right. If the president is insulted, then the citizens are insulted, he said, the late John Foster Dulles had a philosophy based on morality. The irradication of poverty is not the answer to delinquency, he maintained. With respect to slum clearance, it was pointed out that in the speeches of Jesus, He tried to get the slums out of the people.

In conclusion, Dr. McFarland emphasized that training must start early in life, that such training must start within the family, and that the world has other people who have rights. Children should grow into well-adjusted adults. All problems in the community or the country cannot be solved, but it is terribly important that each citizen should give concern to them. On returning home, those who attended the meeting could transpose facts easier if the foregoing matters were kept in mind. The speaker said there should be more and more conventions because industry must have leadership, and it must come from the grass roots.

The speaker was introduced by M. R. Marston, vice-chairman of the Pacific General Meeting, who in turn introduced committee chairmen who made the arrangements for the meeting and the officers.

Technical Sessions

Out of the 172 papers presented in 39 technical sessions during the four days, 65 papers were presented in 14 sessions sponsored by the Aero-Space Transportation Committee. Many of the papers dealt with theory and designs for probing the barriers of outer space and brought progress a step nearer toward the solution of some of the challenging problems presented earlier in the meeting by K. J. Bossart to electrical engineers. Some of the papers in the other sessions sponsored by the Nucleonic and Radiation Instrumentation Committee and the Electrical Insulation Committee dovetailed with the aero-space program and vice versa. In the same way, several of the radio communication and solid state devices papers presented in the Aero-Space Sessions were also of interest to the sessions sponsored by the Radio Communication Systems Committee and the Solid State Devices Committee and vice versa.

Power Generation for Outer Space

Papers were presented which dealt with the four different principles of power generation for outer space; namely, thermoelectric, magnetohydrodynamic, thermionic, and the fuel cell or chemical conversion.

A classic paper, "Magnetohydrodynamic Orbit Control for Satellites," was presented by S. T. Demetriades, head of the Space Propulsion and Power Laboratories, NORAIR Division of the Northrop Corporation. The author analyzed mathematically the velocity requirements for various orbit changes and compared the merits of the electrostatic (ion) and magnetohydrodynamic (plasma) electrical propulsion systems. An airbreathing magnetogasdynamic (MGD) orbital ramjet principle showed considerable promise as

ALMOST anything can happen when AIEE members get together for a General Meeting! Here are four musically talented men who provided the entertainment at the Pacific General Meeting: *(left to right)* George Barcus, General Electric Company, Los Angeles, Calif.; Scott Hanville, Jack & Heintz, Inc., Cleveland, Ohio; E. C. Day, AIEE headquarters, New York, N. Y.; and Lewis Knerr, consulting engineer, LaJolla, Calif.

a means for control of low-altitude satellites. The MGD rocket also showed considerable promise as a means for control of high-altitude satellites. The theory of the MGD ramjet, in which a cryopump was employed and the MGD rocket was developed, with the power requirements was given, as well as some of the design considerations.

Two other papers reported research results with solar thermionic converters. A paper was presented by Henry Oman, research specialist in the Aero-Space Division of Boeing Airplane Company, which described an analytical and experimental investigation of a solar thermionic converter. This paper yielded conclusions that a high-pressure cesium vapor type thermionic converter, heated by sunshine and concentrated by a lightweight mirror, appeared to be the promising power source for space vehicles. A minimum temperature of 740 F yielded 8 watts per square centimeter output at a 10% efficiency. After a few more weeks' experimentation, the author expects to determine whether a thermionic converter is suitable for space use or not.

Solar Powered Thermionic Diode

Another paper, which described the design and experimental results with a solar powered thermionic diode, was presented by M. W. Mueller of the Thompson Ramo Wooldridge, Inc. The diode tested consisted of a tantalum emitter and silver anode with cesium injected. Of four units built, only one got completely assembled which yielded 30 watts per square centimeter. There was reasonable agreement between the vacuum characteristics of these test cells, and the data also agreed fairly well with theoretical emission calculations that were given by the Los Alamos converter. With the introduction of cesium, this diode seemed to excel in both voltage and current output to the Los Alamos data. It appeared that the selection of silver for the anode material, the use of a very high purity tantalum for the cathode, and possibly an assist due to photo-ionization of the cesium vapor, all contributed as expected to the superior performance of this design. Results to date were most promising, and it was particularly interesting to note the high current level attained with a cathode temperature of only 1,860 degrees Kelvin. This ability of a plasma diode to yield high current densities at relatively low temperatures will result in higher efficiency at these temperatures and will simplify the mechanical design of the diode.

As an illustration, the paper sponsored by the Radio Communication Systems Committee that was of particular interest to the aero-space people was exemplified by the presentation entitled "Use of Moon or Satellite Relays for Global Communications" by L. P. Yeh, who was formerly with the General Electric Company, and is at present with Page Communications Engineers, Inc. From a practical system point of view, the author analyzed the extension of global communications by means of moon and satellite relays. In conclusion, both moon and satellite relays are feasible means for the extension of global communications, with the moon relay the most economical in the present state of the art. The usable time of a moon relay is continuous but it is limited and varies from day to day, depending on the locations of the earth stations and the great circle distance between them. With 2½ seconds required for a signal to take a round trip from earth to moon, an immediate response is impossible. Satellite relays may achieve continuous service all the time at all ranges, depending on the number of satellites used and their height. Response time in general is short, but the difficulty seems to be the problem of putting a large number of satellites in precise orbits with a fairly long lifetime. Both moon and satellite relays are subject to certain restrictions such as narrow bandwidth, small signal-to-noise ratio, and low system reliability.

Tally Photography

AIEE President C. H. Linder (*right*) greets K. J. Bossart (*left*), technical director, Convair, Astronautics Division, with J. F. Sinnott (*center*), general chairman, looking on.

New Approaches Presented

Other papers presented new approaches to problems such as the attainment of constant frequency from variable speed generation and the need for the introduction of increased reliability where transistors and solid state devices have been introduced in circuitry. In a paper entitled "Electrical System Transients and Sensitive Circuit Control for Missiles and Space Vehicles," T. B. Owen of the Douglas Aircraft Company set forth considerations to obtain interference suppression by design rather than to obtain the result by a last minute frenzied effort with a pocketful of filters and capacitors. In another paper, "Performance of Electrical Connectors at High Altitude," by A. L. Coates of the Bendix Aviation Corporation, the knowledge of performance of connectors was extended from altitudes of 65,000 feet through the critical area of 100,000-200,000 feet and beyond to 300,000 feet where the pressure drops to approximately 5 microns of mercury.

Student Branch Delegates Conference

Thirty faculty advisers and student officers from Student Branches in Districts 8 and 9 met to discuss and work out plans for Branch activity for the coming school year.

Meeting together in joint session on Thursday afternoon, the delegates were introduced to each other by A. H. Keith, superintendent of the Electronics Division of the San Diego Public Works Department, who was in charge of student affairs at the meeting. Mr. Keith also introduced Harold Foote, AIEE past president, who spoke on engineering education and how the attitudes and skills being taught in engineering schools now will determine the major engineering decisions to be made 40 years from now.

J. A. Peterson, counselor from the University of Santa Clara and chairman of the District 8 Student Activities Committee, also spoke. Mr. Peterson reported on the major actions taken at the Student Branches Committee meeting in Atlantic City, including the elimination of the Affiliate Branch status, and action toward greater unity in the Student Branch programs of the various engineering societies, particularly relating to the Institute of Radio Engineers.

A report was given by John Morrison, Student Branch co-ordinator from Institute headquarters, on the materials being supplied the Branches for their operations this Fall, and the "After Graduation" Panel program to be offered the Branches by the Sections for a job-discussion program to be held at the Branches in late October or early November.

The counselors and students then separated for detailed discussions. The incoming Student chairmen (or their representatives) dealt with many phases of Branch operation, from getting speakers

to getting members. District 8 counselors selected Dr. T. B. Thompson as chairman of the Student Activities Committee, and decided to hold the District Prize Paper Contest at Arizona State in the Spring. The District 9 Contest will be at Washington State University at Pullman, Wash., hosted by Prof. Maoling Liu.

The final word went to President Linder. He spoke of the challenge to the AIEE in seeking increased unity among professional societies.

Considerable interest was shown by counselors and Branch officers there, and an excellent year is anticipated.

Ladies Entertainment

Besides the dinner on Tuesday evening and the Shakespearean play, "As You Like It," as well as the dinner-dance with entertainment on Thursday evening, a busy time was arranged for the visiting ladies under the chairmanship of Mrs. M. R. Marston. A harbor cruise and Hawaiian luau luncheon was arranged on one of the days with a luncheon and fashion show on another day. Each morning there was a coffee hour in the patio, and arrangements were made for those desiring to play bridge as well as visits to special features of interest in San Diego.

Golf Tournament

Competition for the John B. Fiskin Trophy was played over the course of the Mission Valley Country Club, which was the site of the San Diego Open.

The winner of the John B. Fiskin Cup competition was Duke Wheeler, who was given an alpaca golf sweater. G. L. Barkus was second low net and Rocky Rockwell third low net, and they were awarded sport shirts.

Committees

The chairmen of the General Committee and the working committees of the 1960 Pacific General Meeting which made the arrangements were as follows: General Committee, J. F. Sinnott; Finance Committee, A. Paull; Hotel and Registration, L. R. Knerr; Technical Committee, E. F. Kotnik; Student Activities, A. H. Keith; Arrangements, G. B. Kenline; Entertainment, R. K. Walter; Publicity, H. R. Hughes; Transportation and Inspection and Inspection Trips, W. A. Davis; Golf, R. A. Kinslow; Ladies Entertainment, Mrs. M. R. Marston.

Computer Application Conference To Be Held November 9-11 in St. Louis

THE 2nd Power Industry Computer Application (PICA) Conference is planned for November 9-11, 1960, at the Chase Hotel in St. Louis, Mo. The theme of the conference is "Computers and Power—The Brains and Brawn of Industry." More than 400 persons are expected to attend the conference.

J. W. McAfee, president of Union Electric Company, St. Louis, Mo., and M. W. H. Davies, professor of electrical engineering, Queen Mary College, University of London, will be luncheon speakers during the meeting.

Latest developments in digital computers for utility engineering and plant automation will be presented in 25 papers by authors from operating utility companies, electrical manufacturers, and universities, both in this country and abroad. The conference is co-sponsored by the Power Division and Computing Devices Committee of the AIEE.

General sessions at the conference will be devoted to: (1) Power System Analysis by Digital Computer, (2) Computers for System Operation and Optimizing, (3) Computers for System Planning, and (4) Automation and Data Gathering—Computer Control.

In addition, general presentations will cover characteristics of available computer systems and programming techniques, and an outline for the interchange of computer programs. Arrangements for computer services in general service bureaus and at other locations will be discussed.

On the morning of the first day, system analysis by computer will be discussed. The program will open with a conference introduction and information on the exchange of computer programs and the availability of computer services. The morning session will cover several aspects of the application of digital computers in the study of power system short circuits. These will include a new program for a short-circuit study for the application of relays, the calculation of sequence impedance and fault currents for radial primary distribution circuits, the application of computers to determine power circuit breaker duties, and some improved computer techniques for short-circuit studies.

Power System Analysis Problems

System analysis by computers will continue on the afternoon of the first day with discussions of other types of power system analysis problems. These will include the discussion of experiments with mesh analysis for load flow studies, and a digital transient stability program which includes the effects of regulator, exciter, and governor response. Programs of computation of transmission line impedances and for the prediction of radio noise levels will also be discussed in the afternoon session.

The second part of the conference will begin on the morning of the second day, and will consider computers in system operation and optimizing. This session will include such subjects as power generation scheduling by use of digital computers, economic dispatch of generation directly from system admittances and voltages, the economic utilization of hydroelectric plants, and the operation of a hydrothermal electric system. The latter subject makes use of the operational gaming technique being used recently in digital computer programs.

The use of computers in system planning is the third part of the conference, and it will begin on the morning of the third day. This session will cover such subjects as system planning simulation and operational gaming by computers. Individual discussions will cover electric utility service cost analysis, incremental production costs, a solution to the unit requirement problem in generation expansion planning, the determination of fuel and investment costs for future generation systems, and transmission limitations determined by superposition.

Approaches to Use of Computers

On the afternoon of the third day, automation, data gathering, and computer control will be the subject for discussion. A number of approaches to the use of computers, both on-line and off-line, for power plant start-up, operation, shutdown, and data gathering and processing will be discussed. These will include a résumé of the National Power Conference sessions on plant automation.

To give those attending the conference a chance to relax and get better acquainted, a cocktail party and banquet are planned for Wednesday evening, November 9. The cocktail party will begin at 6 p.m. in the Chase Hotel's Zodiac Room, followed by the banquet in the Starlight Roof at 7 p.m. Professional entertainment will be a feature of the after-dinner program.

St. Louis is a transportation hub for travel in all directions, and is served by all types of public conveyance as well as several federal highways. Railroads serving St. Louis include the Wabash, Missouri-Pacific, and Frisco from the South and West; the Pennsylvania, New York Central, Wabash, G.M. & O., and Baltimore & Ohio from the North and East. Airlines to St. Louis include Trans World, American, Delta, and Ozark. St. Louis is also served by the major bus lines. Those who plan to drive can follow U.S. 40 or 50 from the East or West, U.S. 66 from Chicago or the Southwest, and U.S. 61 or 67 from the North or South.

An inspection tour of a large computer center in the St. Louis area is planned for Thursday afternoon, November 10.

The installation to be visited is the McDonnell Automation Center, a division of McDonnell Aircraft Corporation. This new center in St. Louis County is the largest commercial electronic data processing operation in the Midwest, where more than 250 specialists, using equipment valued at more than $7 million, provide business and scientific computer service to mid-America. The installation includes IBM *709* and *705* computers, a 240-amplifier PACE analog facility, an analog network analyzer, and a Burroughs Datatron *204*.

A special feature of this meeting will be an afternoon and evening for discussion groups to talk over specific areas of interest in engineering or control. Discussion

Edwyn Portrait

J. W. McAfee
Featured Speaker

subjects will be welcomed by the conference program chairman, Dr. E. L. Harder, Westinghouse Electric Corporation, 700 Braddock Ave., East Pittsburgh, Pa.

Registration

Initial mailing of the conference program will include return cards for advance registration and hotel reservations. Badge and tickets will be ready to be picked up at the registration desk for those registering in advance.

Registration fees are $6 for members and $10 for nonmembers. No charge will be made for ladies or students. Tickets for the banquet Wednesday are priced at $7.50 per person, and for each of the luncheons $4 per person.

The registration desk will be open from 6 to 9 p.m. Tuesday evening, November 8, for those who arrive the day before the conference begins. During the conference, the desk will be open 8 a.m. to 5 p.m. Wednesday, 8:30 a.m. to 5 p.m. Thursday, and 8:30 a.m. to 12 noon Friday.

Room rates at the Chase-Park Plaza Hotel are approximately as follows:

Singles	$10-15
Doubles	$13-17
Twin Beds	$14-20
Suites	$23-72

Members of the National Conference Committee are F. J. Maginniss, chairman; E. L. Harder, program chairman; F. J. Kovalcik, national publicity; and R. S. Gardner, AIEE Headquarters. St. Louis Section Conference Committee members are G. S. Whitlow and P. M. Honnell, co-chairmen; F. R. Arnoldy, finance; D. P. Ayers, meeting facilities; J. R. Burkhart, registration; J. A. Bussmann, Jr., hospitality; and F. R. Summers, publicity.

Technical Program

The tentative technical program for the 2nd PICA Conference is as follows:

Tuesday, November 8

6:00 p.m. Registration

Wednesday, November 9

8:00 a.m. Registration

Bob Barrett

COMPUTERS for engineering and power will be explored under the direction of F. J. Maginniss *(left)*, conference chairman, and Dr. E. L. Harder *(right)*, program chairman, at the 2nd Power Industry Computer Application Conference. Authors from this country and abroad will present 25 technical papers at the meeting co-sponsored by the Power Division and Computing Devices Committee of the AIEE.

McDonnell Aircraft Corporation

THIS IBM 709 digital computer at the McDonnell Automation Center will be viewed on an inspection trip taken during the 2nd Power Industry Computer Application Conference. The Center is the largest commercial electronic data-processing operation in the Midwest. Equipment valued at more than $7 million is used here by 250 specialists to solve business and scientific problems.

10:00 a.m. Session I—System Analysis by Computer—I

Chairman: Dr. P. M. Honnell

Conference Introduction and Information on Program Exchanges and Available Computer Services. F. J. Maginniss, General Conference chairman.

New Digital Computer Short-Circuit Program for Relay Studies. *G. E. Taylor, G. K. Carter, E. H. MacDonald.*

Digital Calculation of Sequence Impedances and Fault Currents for Radial Primary Distribution Circuits. *R. C. Ender, G. G. Auer, R. A. Wylie.*

Short-Circuit Improvements through Better Computer Techniques. *R. W. Long, R. T. Byerly, C. W. King.*

Computer Application to Determination of Power System Circuit Breaker Duties. *M. J. Lantz.*

12:15 p.m. Luncheon

Speaker: J. W. McAfee, president, Union Electric Co.

2:30 p.m. Session II—System Analysis by Computers II

Chairman: C. A. MacArthur

General Conference Talk—Characteristics of Computers for Power System Calculation. *J. T. Carleton.*

Digital Programs for Computation of Transmission Line Impedances. *Norton Savage.*

A Digital Transient Stability Program Including Effects of Regulator, Exciter, and Governor Response. *C. C. Young, M. S. Dyrkacz, F. J. Maginniss.*

Load Flow Using Mesh Analysis. *L. J. Rindt, C. W. King, R. W. Long.*

Prediction of Radio Noise Levels by Digital Techniques. *L. O. Barthold, A. K. Abboushi.*

Load Flow Computation by Matrix Method. *H. E. Brown, C. E. Person.*

A Digital Approach to Power System Engineering—III. *J. L. McKinley, G. B. Reed.*

6:00 p.m. Cocktail Party—Zodiac Room, Chase Hotel.

7:00 p.m. Banquet—Starlight Roof, Chase Hotel.

Thursday, November 10

9:00 a.m. Session III—Computers in System Operation and Optimizing

Chairman: A. P. Hayward

General Conference Talk—Use of Computers in Operations. *Dr. L. K. Kirchmayer.*

Use of Computers in Generation Scheduling. *P. G. Lubisich.*

Use of Digital Computer To Improve Selection of Generating Units To Be Operated. *W. H. Osterle.*

Computer Selection of Generating Units To Be Operated—Part I—Economic Evaluation on a Small Computer. *W. H. Osterle, J. Geiser.*

Computer Selection of Generating Units To Be Operated—Part II—by Dynamic Programming on a Large Computer. *W. H. Osterle, J. Geiser, C. A. DeSalvo, K. M. Dale.*

The Economic Utilization of Hydroelectric Plants. *M. W. H. Davies.*

Operation of a Hydrothermal Electric System—A Gaming Problem. *J. Lindqvist.*

Economic Dispatch of Generation Directly from System Admittances and Voltages. *R. B. Squires.*

Afternoon—Inspection Trip to McDonnell Automation Center

Small computer demonstrations at hotel. Discussion groups on selected topics.

Friday, November 11

9:00 a.m. Session IV—Computer Use in System Planning

Chairman: Dr. E. L. Harder

General Conference Talk—Digital Computers in Power Systems Planning. *K. M. Smith, E. L. Michelson.*

Computer Applications of Incremental Production Costing. *K. M. Dale, C. A. DeSalvo, C. W. King.*

Electric Utility Service Cost Analysis. *Y. J. Fujimura.*

Transmission Limitations Determined by Superposition. *C. A. MacArthur.*

Computers Applied to the Optimal Design of Generation and Transmission Systems. *L. K. Kirchmayer.*

A Digital Program To Determine Fuel and Investment Costs for Future Generation Systems. *W. F. Pfeifer, Jr., L. W. Coombe.*

12:15 p.m. Luncheon

Speaker: Prof. M. W. H. Davies, professor of electrical engineering, Queen Mary College, University of London.

2:00 p.m. Session V—Automation and Data Gathering—Computer Control

Chairman: L. B. LeVesconte

Résumé of the National Power Conference Sessions on Plant Automation. *D. M. Sauter.*

Automatic Computer Control and Supervision of a Generating Station. *R. B. Squires, J. W. Skooglund.*

Application of Information Systems to Power Plants. *L. E. Jensen.*

General Purpose On-Line Computer System for Control of Electric Power Generating Stations. *H. O. Jacobson.*

Application Considerations for Computer Monitoring or Control of Start-Up and Shut-Down Procedures for Steam-Electric Plants. *T. H. Lee, R. G. Livingston.*

Data-Gathering and Transmission System for Project EHV. *P. A. Abetti, D. W. Caverly, D. D. Davis.*

New Vice-President Is Elected for AIEE Middle Eastern District 2

H. H. SHEPPARD (AM '34, M '51) of Philadelphia, Pa., has been elected vice-president of the Institute from the Middle Eastern District 2 to fill the unexpired term, to July 31, 1961, vacated by D. L. Greene of Reading, Pa., who moved to Okinawa on an assignment that is expected to keep him away from home for about a year.

Mr. Sheppard, whose election by the Board of Directors was confirmed on September 1, is vice-president of Rumsey Electric Company. He is a graduate of the University of Pennsylvania, Moore School of Electrical Engineering, B.S. 1932 and M.S. 1933, and is a member of Eta Kappa Nu. He was associated with Philco Radio and Television Company prior to his present position with Rumsey Electric Company.

As chairman of the AIEE Sections Committee (1957-59), vice-chairman of the United Engineering Center Member Gifts Committee, and vice-chairman of the 1960 AIEE Summer General Meeting, Mr. Sheppard is known throughout the Institute. He is past chairman of the Philadelphia Section, is presently first vice-president of the Pennsylvania Society of Professional Engineers' Philadelphia Chapter, and is a member of both the Philadelphia and New York Engineers Clubs.

D. L. Greene, the retiring vice-president, who is assistant chief electrical engineer of Gilbert Associates, has been appointed superintendent of transmission of Gilbert Pacific, Inc., with headquarters in Okinawa. A biographical sketch of Mr. Greene was published by *Electrical Engineering* in the April 1959 issue, on p. 389.

D. L. Greene

Rareshide

H. H. Sheppard

Marquette University Becomes 10th NEC Participant

Marquette University of Milwaukee, Wis., has been added as a participant of the National Electronics Conference (NEC). Dr. L. W. Von Tersch, NEC president, stated that Marquette becomes the 10th NEC participant, and as a participant will be represented on the NEC Board of Directors. Marquette University, through this representation, will contribute to the management of NEC programs and activities.

The 16th Annual Conference will be held in Chicago, Ill., at the Sherman Hotel on October 10-12. Sponsors of the conference are: AIEE, Illinois Institute of Technology, Institute of Radio Engineers, and Northwestern and Illinois Universities.

Participants of the conference, in addition to Marquette, are seven universities—Notre Dame, Purdue, Michigan State, Wayne State, Michigan, Wisconsin, and Iowa State—the Electronic Industries Association, and the Society of Motion Picture and Television Engineers.

Conference on Application of Electrical Insulation Planned

Relating the fundamentals of electrical insulation to practical application will be the purpose of two special technical sessions to be introduced in this year's National Conference on the Application of Electrical Insulation. This innovation, part of a technical program to be held at the Conrad Hilton Hotel, Chicago, Ill., on December 5-8, 1960, will provide the basis for improved understanding and communication between the electrical design engineer and the marketer of electrical insulation materials. Discussions in this area will also be of considerable interest to students in the field of electrical engineering.

The first session, under the chairmanship of A. E. Javitz, special feature editor of *Electrical Manufacturing* magazine, is entitled, "Molecular Key to Electrical Insulation Properties."

The following papers will be presented:

The Need To Know. *N. B. Bashara*, University of Nebraska.

The Molecular Blocks of Insulating Materials. *Jack Swiss*, Westinghouse Research Laboratories.

The Relationship of Molecular Structure to Properties of Gaseous and Liquid Dielectrics. *H. B. Pfeiffer*, General Electric Research Laboratory.

The Relationship of Molecular Structure to Properties of Solid Dielectrics. *C. R. Vail*, Duke University.

Molecular Consideration in Selection of Composite Insulating Materials and Insulating Systems. *A. J. Warner*, Aerovox Corp.

G. L. Moses, manager, services engineering, large rotating apparatus department, Westinghouse Electric Corporation, is chairman of the second series entitled "Guideposts to the Application of Electrical Insulation."

Aimed at marketers of electrical insulation, papers will delineate the proper use of electrical insulation in transformers, electronics, and rotating machinery. These subjects will be covered by the following papers:

Fundamentals of Insulating Transformers. *M. L. Manning*, South Dakota College.

Fundamentals of Insulating Motors. *Robert Kaplan*, Louis Allis Co.

Electrical Insulating Materials. *Gordon Gaine*, Westinghouse Electric Corp.

Solid-State Circuits Conference Papers Invited

The 1961 International Solid-State Circuits Conference, the 8th annual meeting, will be held February 15-17, 1961, on the campus of the University of Pennsylvania and the Sheraton Hotel, Philadelphia, Pa.

The conference, sponsored jointly by the AIEE, the Institute of Radio Engineers, and the University of Pennsylvania, will feature papers dealing with circuit properties, circuit philosophy, and design techniques related to solid-state devices in the following general areas:

1. Solid-state memory, storage, and logic elements, such as twistors, thin-film memories and associated circuits, photoelectronic circuitry, etc.
2. Solid-state microwave amplifying mechanisms, such as parametric amplifiers and masers.
3. Solid-state devices performing an integrated circuit function.
4. Cryogenic digital and linear applications.
5. Novel types of solid-state devices in unique modes of operation, such as those utilizing the Hall effect, high-temperature circuit elements and solid-state filters and delay lines.
6. Advanced circuitry, with emphasis on significant developments in the art, to the exclusion of data on equipment design.

Papers representing original contribution in these and related fields are invited.

Abstracts, highlighting the nature of the contribution, its significance in the art, and theoretical and experimental results, 300 to 500 words in length, which can be accompanied by key illustrations, plus 50-word summaries for advance program mailings, should be submitted in double-spaced typewritten form (and in triplicate) on or before October 14, 1960, to the program chairman: J. J. Suran, Building 3, Room 115, General Electric Company, Electronics Park, Syracuse, N. Y.

Abstracts and summaries should be accompanied by author's name, company affiliation and position title, business and home adress, telephone contact, and a brief biographical sketch.

Members of the 1961 conference committee include: T. R. Finch, Bell Telephone Laboratories, Murray Hill, N. J., as chairman; F. H. Blecher, Bell Telephone Laboratories, Murray Hill, N. J., as secretary; Lewis Winner, 152 W. 42nd St., New York 36, N. Y., in charge of public relations.

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until October 27. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE 33 W. 39th St., New York 18, N. Y., on or before October 27.

60-68 **Transient Thermal Impedance of Semiconductor Devices.** *E. J. Diebold, Werner Luft*

60-69 **Power Semiconductor Ratings Under Transient and Intermittent Loads.** *F. W. Gutzwiller, T. P. Sylvan*

60-122 **A Comparison of Digital Differential Analyzer and General-Purpose Equipment in Guidance Systems.** *M. M. Dickinson*

60-637 **Studies of Electrodynamic Forces Occurring at Electrical Contacts.** *A. C. Snowdon*

60-639 **New Contactorless Precision D-C Hoist Has Wide Speed Range and Torque Control.** *Ansgar Hansen, J. H. Karlson, Robert Mierendorf*

60-654 **Error-Correcting Codes for Correcting Bursts of Errors.** *J. E. Meggitt*

60-662 **Protection for Underwater Instruments.** *H. E. Edgerton, L. D. Hoadley*

60-790 **"Datacom" Unit—An Experimental Data Transmission Subset.** *R. E. Stoffels*

60-806 **Miniaturized Current Transformers for Multirange Operation of Milliammeter Ink Recorders.** *W. A. Geyger*

60-811 **New Television Network Switching Facilities.** *A. E. Bachelet, C. A. Collins, E. R. Taylor*

60-813 **A Transistor Automatic Gain Control System for Audio Frequencies.** *J. Shirman*

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y.

Symposium on Reliability and Quality Control Scheduled

For the 7th consecutive year, the industrial and military organizations of the free world are joining hands to contribute to the goal of maximum reliability in electronics through research, engineering, education, and a free exchange of scientific knowledge and achievements. A medium for such exchange is the 7th National Symposium on Reliability and Quality Control to be held at the Bellevue-Stratford Hotel in Philadelphia, Pa., on January 9-11, 1961.

Sponsored by AIEE, the IRE (Institute of Radio Engineers), ASQC (American Society for Quality Control), and the EIA (Electronic Industries Association), the annual symposium attendance has reached 1,500 persons consisting of scientists, engineers, manufacturers, suppliers, techni-

cians, and members of management and military personnel from all over the world. The aggregate membership of the sponsoring societies alone totals well over 100,000.

In addition, there are thousands of individuals from other professional societies, universities, technical schools, and industrial organizations, who are also interested in the activities of the symposium and its contribution to the advancement of reliability and quality control.

ASME Awards Presented to Power Generation Specialists

Three engineers, specialists in the field of power generation, have won awards for their achievements from the American Society of Mechanical Engineers (ASME). One of the award winners is an AIEE Fellow.

J. H. Harlow (M '43, F '58), chief mechanical engineer of the Philadelphia Electric Company of Pennsylvania, received the Prime Movers Committee Award for his contribution to the literature of the power field. His winning paper is entitled "Engineering the Eddystone Plant for 5,000-pound 1,200-Degree Steam."

The other two award winners are E.C. Gaston, president, Executive Division, Southern Services, Inc., Birmingham, Ala., and S. N. Fiala, vice-president and chief engineer, American Gas and Electric Service Corporation, New York. Mr. Gaston was awarded the ASME George Westinghouse Gold Medal for "distinguished leadership in generating station design and operation in the development of a major power system." Mr. Fiala received the Prime Movers Committee Award for his paper, "The Critical and Two-Phase Flow of Steam."

The three men received their awards at the National Power Conference, September 21-23, in Philadelphia. The conference was sponsored by AIEE and ASME.

In addition to the awards to Mr. Fiala and Mr. Harlow, 11 other men were recognized for their supporting papers on the same topics. They are:

First Commercial Supercritical Pressure Steam Turbine Built for the Philo Plant. *C. W. Elston, R. Sheppard.*

First Commercial Supercritical Pressure Steam Generator for Philo Plant. *W. H. Rowxand, A. M. Frenberg.*

The Eddystone Superpressure Unit. *C. B. Campbell, C. C. Franck, Sr., J. C. Spahr.*

Water-Treatment, Corrosion and Internal-Deposit Studies for Eddystone. *R. C. Ulmer, H. A. Grabowski, R. C. Patterson.*

Engineering the Eddystone Steam Generator for 5,000-psig 1,200-Degree Steam. *E. M. Powell.*

Los Angeles Section Sponsors Appliance Conference

The 2nd Western Appliance Technical Conference, sponsored by the Los Angeles Section, AIEE, will be held at the Biltmore Hotel, in Los Angeles, Calif., on November 7, 1960.

This conference will be of value to those associated with electrically controlled equipment or appliances for the home. It will deal with appliances of both electric and gas design. All major segments of the appliance industry will be represented, including home comfort, cooking, major appliances, small appliances, and specialized products.

All interested engineering, sales, and management people are invited to attend. Close association with the electrical industry or membership in the AIEE is not required.

Subjects will be presented by equipment manufacturers, component suppliers, public utilities (both gas and electric), and private organizations devoted to safety.

Papers concerning design application, codes, and standards will be presented in the morning and afternoon sessions.

For the evening session, there will be an interesting seminar pertinent to the application of electrical components on gas appliances.

Ladies Fall Meeting Program To Feature Sight-Seeing Cruise

The Ladies' Activity Committee for the 1960 AIEE Fall Meeting in Chicago, Ill., has arranged a program for Thursday, October 13.

Buses will take the ladies to the harbor, where they will board a heated, enclosed yacht for a sight-seeing trip along Chicago's famous lake shore. The cruise will end at the Chicago Yacht Club, where luncheon will be served. After lunch, the port director of the City of Chicago Port Authority will give a brief talk on Chicago's role as a world port.

This day's entertainment will be one of the highlights of a crowded week that includes a trip to the Old Orchard shopping center, a book review by Purdy Meissner, an afternoon devoted to tips by a representative of Trans World Airlines on what to wear while traveling, a fur fashion showing, a brunch in the Carousel Room, and a strolling caricaturist. A suite has been reserved for reading, lounging, bridge, and a daily morning coffee hour.

Women's Auxiliary Presents Education Award

The Women's Auxiliary to the Maryland Section, AIEE, has presented $400 to the electrical engineering department of the Johns Hopkins University.

The purpose of this gift is to provide funds for a scholarship award, to be given to a senior undergraduate student in electrical engineering for the 1960-61 academic year.

This is the second such annual award to be presented by the Auxiliary. The funds are raised by annual card parties sponsored by this active women's group which are held in the spring of each year.

The presentation was made by Mrs. Edward Kaminski, 1959-60 chairman. The Auxiliary is entering its fourth year of activity with a membership of 114. The present chairman is Mrs. Anthony Schettler.

PRESENTATION of the Maryland Auxiliary's Education Award of $400 was made by Mrs. Edward Kaminski (*second from right*) to R. L. Strider (*seated*), director of financial aid at the School of Engineering of the Johns Hopkins University. Others in the photo are: (*standing, left to right*) Mrs. Joseph Kaminski; R. H. Roy, dean of the School of Engineering; Mrs. R. D. Bader; Mrs. J. M. Graff; and (*at right*) Mrs. Anthony Schettler.

EJC Delegation Returns from Mission to Soviet Union

An Engineers Joint Council (EJC) delegation has recently returned from a 4-week trip to the Soviet Union where the group studied at first hand the utilization and interrelationship of Soviet engineers and engineering technicians.

Members of the team were W. E. Lobo, consulting chemical engineer, New York, N. Y.; H. R. Beatty, president, Wentworth Institute, Boston, Mass; C. S. Dargusch, advisor, Engineering Manpower Commission, Columbus, Ohio; Oleg Hoeffding, economist, Rand Corporation, Santa Mon-

ica, Calif; S. B. Ingram, director of technical employment, Bell Telephone Laboratories, Inc. Murray Hill, N. J.; and R. M. Mahoney, manager of industrial relations development, Union Carbide Corporation, New York, N. Y. A photo of the delegation appeared in the September issue of *Electrical Engineering*, p. 760.

The itinerary covered Moscow, Leningrad, Kharkov, Rostov, Baku, Tashkent, and Samarkand. Thirteen technical institutes, three technicums, and five industrial plants were visited.

They found engineering education in general of high quality, with greater theoretical and mathematical content than is found in United States engineering curricula. Technicums operate an efficient and effective program to produce technicians, turning out 250,000 industrial technicum graduates annually, according to Soviet officials. This compares with 14,000 to 16,000 graduated annually in the United States. Each year, 108,000 engineers graduate; however, many are assigned to jobs to which engineers would not be assigned in the United States. It is not uncommon, apparently, for an engineer on his first assignment to serve as a technician or even in the worker category. About one third of the students in engineering institutes and technicums are women.

One of the significant changes in higher educational policy within the last few years requires that most high school graduates spend 2 years in practical work in industry before continuing their education.

The delegation firmly believes that to maintain our position in the highly competitive world situation, we should give more serious thought to education especially in the area of motivation.

AIEE PERSONALITIES

A. V. K. Babcock (AM '45), manager of the Area Development Department of the Arizona Public Service Company, Phoenix, Ariz., is touring principal cities and commercial and industrial centers in Afghanistan and Iran during August 20-October 8 as a member of the United States' first Trade Mission to both countries. On its return to the United States, the Mission will report its findings to the business community at a conference in a leading city to be selected on the basis of its most direct interest in trade and investment with Afghanistan and Iran.

R. C. Boe (AM '51) has been appointed marketing manager of the Buffalo Operations of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc., New York, N. Y. Prior to joining Sylvania, Mr. Boe was marketing manager and assistant to the vice-president and general manager of the Cook Technological Center, Chicago, Ill.

G. E. Borthig (AM '58) has been appointed technical representative for insulating varnishes. He will service selected Schenectady accounts in the Greater New York—Metropolitan territory, which includes adjacent Connecticut and New Jersey areas. Mr. Borthig was formerly affiliated with the George C. Borthig Company in various sales and electrical engineering positions.

G. M. Boyd (AM '57) has been appointed manager—engineering of the insulator department, General Electric Company, Baltimore, Md. He succeeds **H. A. Frey** (AM '28, F '51), now general manager of the insulator department. Mr. Boyd joined the insulator department in 1948. Mr. Frey has served on the AIEE Transmission and Distribution Committee (1949-60) and Special Instruments and Auxiliary Apparatus Committee (1956-60).

G. G. Brooks (M '58), formerly manager of product sales in the control department, Allis-Chalmers Manufacturing Company, has been transferred to Allis-Chalmers associate company, Consolidated Systems Corporation, Monrovia, Calif., where he is in charge of industrial systems.

G. M. Brunzell (AM '40, M '50) was elected president of the Washington Water Power Company, Spokane, Wash., on May 13. He was previously executive vice-president.

A. B. Buchanan (AM '24, M '33), assistant communication engineer, Detroit Edison Company, Detroit, Mich., retired August 1 after 38 years with the company, engaged primarily in radio and electronic engineering projects. He plans to specialize in the field of mobile radio systems as a consulting engineer.

Robert Chowanetz (AFFIL '55) has been named laboratory manager for the electrical product development department of Thompson Ramo Wooldridge's Tapco Group, Cleveland, Ohio. The new assignment includes responsibility for the Fabrication Laboratory, Electrical Laboratory, and Instrumentation Laboratory at the Platt Avenue facility, and environmental facilities at Platt and the Clarkwood plant. Most recently, Mr. Chowanetz served as a research engineer in the New Devices Laboratories at Platt.

J. A. Clark (AM '40, M '49) has been named to head the development of equipment requiring low-cost production design in the development phases for the electrical product development department of the Tapco Group, Thompson Ramo Wooldridge Inc., Cleveland, Ohio.

Robert Coats (AM '56) has been appointed manager, engineering and production, of Magnetic Metals Company's new Western Division. Mr. Coats is in charge of process and design engineering, as well as manufacture of tape-wound Centricores at the company's new plant at Newport Beach, Calif. Prior to joining Magnetic Metals, he was employed by Arnold Engineering of Marengo, Ill., as a quality control and design engineer.

A. B. Credle (AM '35, M '43) has assumed new technical responsibilities at the International Business Machines Corporation's Advanced Systems Development Division Laboratory in Ossining, N. Y. Dr. Credle, who previously was with the corporate staff in charge of engineering standards, has become manager of exploratory engineering, a new laboratory position.

First Stainless Steel Erected on U.E.C.

STAINLESS steel window grids for the glass-walled east base of the United Engineering Center were being lifted into position when this photo was taken. A display area of 6,235 square feet will be enclosed by the wall. This is the first installation of some 170,000 pounds of stainless steel that will provide beauty and durability to the skyscraper's exterior. The gleaming gridwork of stainless steel mullions on the slab-shaped building will be further accented by five columns on the south and four on the north rising from ground level to the top of the 283-foot-high structure.

Marquardt-Weinberg

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

C. E. Cunningham (AM '47, M '56) has been promoted to senior supervising engineer in the Technical Division at the Baytown, Texas, refinery of Humble Oil & Refining Company's Humble Division.

R. J. Dikeman, Jr. (AM '55) has been named marketing manager of MULTI-AMP Electronic Corporation, Union, N. J. Prior to joing MULTI-AMP, Mr. Dikeman was a sales engineer with I-T-E. Circuit Breaker Company.

A. B. Du Mont (F '43) has been appointed group general manager of the Allen B. Du Mont Laboratories Divisions of Fairchild Camera and Instrument Corporation, Clifton, N. J. The Allen B. Du Mont Laboratories were merged into the corporate structure of Fairchild Camera and Instrument Corporation of Syosset, N. Y., on July 5. Dr. Du Mont will have the over-all management responsibility for the Electronic Tubes Division and the Industrial Electronics Division. Immediately prior to the merger, Dr. Du Mont was chairman of the Board of Directors and general manager of Allen B. Du Mont Laboratories, Inc.

Ted Dunnegan, Jr. (AM '54), has been named acting division manager of the Electronics Division of Temco Electronics & Missiles Company, subsidiary of Ling-Temco Electronics, Inc. He succeeds **A. R. Teasdale, Jr.** (AM '43, M '50), who resigned to become technical consultant with The Martin Company, Baltimore, Md. Mr. Dunnegan was formerly manager of special projects where he directed electronic work on the Corvus missile and the video correlator. Mr. Teasdale has served with the Feedback Control Systems Committee (1952-60).

George Dupree (AM '40, M '50), an Amarillo executive of the Southwestern Public Service Company, has taken on the duties of director of rates and budgets of the company.

E. C. Dwelle (AM '48), has retired from the James R. Kearney Corporation, St. Louis, Mo., where he served for 33 years as sales representative and district manager of the company's Texas and New Mexico territory.

T. N. Feng (AM '52) has been appointed associate director of research, Control Data Corporation, Minneapolis, Minn. Prior to joining Control Data, Dr. Feng held the position of consulting engineer in the Avionics Division of John Oster Manufacturing Company, Racine, Wis.

J. H. Fisher (AM '53) has been named a vice-president of Electro-Optical Systems, Inc. Dr. Fisher joined Electro-Optical as manager of the Energy Research Division in 1958.

J. L. Fuller (AM '37, F '59) is a partner in the firm of John L. Fuller and Associates, formed recently in Cleveland, Ohio, for the joint purposes of consulting and product development engineering. The firm will operate as consultants in the field of electrical and mechanical devices, with emphasis on controls and systems (electrical, mechanical, pneumatic, and hydraulic), governors, clutches, electric motors and generators, pumps, vibration and noise problems, and instrumentation. Plans have also been made to open a development laboratory in Cleveland.

Robert Garmezy (AM '50, M '55) has been appointed director of engineering of Blackstone Corporation, Jamestown, N. Y. Mr. Garmezy has been associated with Blackstone since 1951. In his new capacity, he will co-ordinate and direct activities of design, research, development, and test groups in the Automotive Division.

S. K. Ghandhi (AM '59) has been named manager of Solid-State Circuit Research for Philco Corporation's Research Division. Dr. Ghandhi was a staff member of the General Electric Electronics Laboratories at Syracuse, N. Y., for 9 years before joining Philco. He has served on the AIEE Solid State Devices Committee (1959-60).

K. E. Glover (AM '51, M '58) has joined the Commercial Apparatus and Systems Division of Raytheon Company, Waltham, Mass., as manager of new business development. Mr. Glover joined Raytheon from Sanders Associates of Nashua, N. H.

Arthur Goldsmith (AM '38, M '45) has been appointed to the post of director of engineering of Wilcox Electric Company, Inc., Kansas City, Mo. Dr. Goldsmith had been on active duty with the U. S. Navy in various engineering and executive positions in communications and electronics.

A. S. Gray (AM '41) has been elected general manager of Insulation Manufacturers Corporation and of Macallen Company, Inc. Mr. Gray had been an officer and director of both companies.

E. I. Green (AM '23, F '46) has been elected to the board of directors of United-Carr Fastener Corporation, Boston, Mass. Mr. Green is executive vice-president of Bell Telephone Laboratories. He has served on the following AIEE Committees: Instruments and Measurements (1942-50, chairman 1947-49); Science and Electronics Division (1950-54, chairman 1950-52); Planning and Co-ordination (1952-60); Award of Institute Prizes (1952-56, chairman 1952-54); Publications (1957-60); Education (1958-60); Finance (1959-61); Edison Medal (1959-61); Communication Division (1959-60); and Executive (1960-61).

R. M. Grogan (M '46), assistant manager in the Office of Production Transmission and Construction, has become manager of this office in the Long Island Lighting Company, Mineola, L. I., N. Y.

J. M. Ham (AM '44, M '53), professor of electrical engineering at the University of Toronto, is chairman of the Associate Committee of Canada's National Research Council. This committee was formed to deal with problems of national scope in the field of automatic control. Dr. Ham has served on the AIEE Feedback Control Systems Committee (1955-60).

C. E. Hammond (AM '46, M '57) has been named Central Pacific district manager of apparatus marketing for Westinghouse Electric Corporation. Formerly manager of industrial sales for Westinghouse apparatus, with headquarters in East Pittsburgh, Pa., Mr. Hammond succeeds **H. G. Rethmeyer** (AM '45), who has been appointed special representative for Westinghouse in the Pacific Coast region.

V. H. Harris (M '48) has been named manager of the New Projects Office of Vitro Laboratories, West Orange, N. J. He has been head of the arc research and development department at West Orange.

L. K. Hart (AM '41, M '51) has been appointed general manager of the Regent Electric Supply Company, a division of the Union Electric Supply Company Ltd., Toronto, Ont., Canada.

C. W. Higbee (M '37), assistant general manager of the Electrical Conductor Division, Kaiser Aluminum & Chemical Corporation, retired on July 1. After his return from military service in France during World War I, Mr. Higbee joined the U. S. Rubber Company where he rose to manager of the wire and cable department. In 1957, Kaiser Aluminum purchased U. S. Rubber's wire and cable business and he joined the new organization as assistant general manager of the Electrical Conductor Division. A dinner honoring Mr. Higbee's long service to the industry was attended by employees and division executives on June 24 in Oakland, Calif.

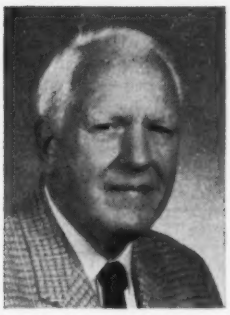
C. L. Hogan (M '57), general manager of Motorola's Semiconductor Products Division, has been named a vice-president of the corporation. Dr. Hogan will continue to manage the Phoenix-based semiconductor activity. He has served on the AIEE Basic Sciences Committee (1958-60).

L. C. Holmes (AM '31, F '51), director of engineering operations at the Stromberg-Carlson Division of General Dynamics Corporation, has been designated co-ordinator of all co-operative education programs at the division. Mr. Holmes has served as vice-president of AIEE District 1 (1958-60) and on the following AIEE Committees: Research (1958-60) and Recognition Awards (1959-62).

R. W. Inman (AM '51), formerly executive vice-president, has been named president of Associated Research, Inc., Chicago, Ill.

D. E. King (AM '41, M '49) has been named supervisory engineer, special control, engineering group, of Allis-Chalmers Manufacturing Company's control department. Mr. King joined Allis-Chalmers in 1954 as an engineer in the control department. He has served on the AIEE System Engineering Committee (1958-60).

E. C. James (AM '41, M '53), formerly chief engineer, Sewaren Generation Sta-



E. B. Kurtz

R. J. W. Koopman

tion, has become chief engineer, Mercer Generating Station, of the Public Service Electric and Gas Company, Newark, N. J.

R. J. W. Koopman (AM '36, F '53), professor of electrical engineering and department head, Washington University, has been named president of the Engineers' Club of St. Louis, Mo. Dr. Koopman had been chairman of the Professional Recognition Committee of the Engineers' Club (1950), a director (1953-55), treasurer (1956), and vice-president (1957-60). He has served on the following AIEE Committees: Aircraft and Flight Test Instrumentation (1956-60, chairman 1959-60); Telemetering (1958-60); and Instrumentation Division (1959-60).

E. B. Kurtz (AM '20, F '29, Member for Life), professor and head of the electrical engineering department at the State University of Iowa for the last 31 years, has become emeritus professor. He was also professor and head of the electrical engineering department of Oklahoma State University (1925-29), during which time he was branch counselor. Dr. Kurtz was branch counselor at Iowa State for 31 years.

R. E. Lawhead, Jr. (AM '47, M '59) was feted at a luncheon given in San Jose, Calif., to mark the completion of 25 years of distinguished service with International Business Machines Corporation. Mr. Lawhead joined the corporation's Endicott, N. Y., installation in 1935. Concentrating his efforts in the field of magnetic recording, Mr. Lawhead received various promotions until he attained the position of senior development engineer in 1950. He held the position of manager of the Product Design Group from 1954 until he was transferred, the next year, to San Jose. He subsequently assumed his current position with the Advanced Systems Development Division Laboratory.

R. N. McCowen (AM '50) was recently promoted by Southern States Equipment Corporation to Southwest regional manager. Mr. McCowen was formerly district manager. He will continue to operate from Southern States field office in Dallas, Texas.

R. D. Mohler (AM '52, M '58) has been named assistant chief engineer in charge of the Product Research Section of Motorola Inc., Chicago, Ill. Prior to this appointment, he was assistant head of this section.

R. E. Nolte (AM '53, M '55) has been appointed chairman of the department of electrical engineering at the Missouri School of Mines and Metallurgy. He succeeds **I. H. Lovett** (AM '20, F '50, Member for Life), who retired and received the title, professor emeritus, at the Spring commencement. Dr. Nolte joined the school faculty in 1949 as assistant professor. In the electrical engineering department, he has been the major professor for research in the master's thesis programs.

M. L. Priban (AM '49) has joined the Goss Company, Chicago, Ill., a division of Miehle-Goss-Dexter, Inc., as staff electrical engineer. Prior to this association, he was chief engineer of the Cline Electric Manufacturing Co., Chicago.

W. L. Ringland (AM '36, M '44), chief engineer of Allis-Chalmers motor and generator department, received Allis-Chalmers Manufacturing Company's first Scientific and Engineering Award. The prize consisted of a medallion, a certificate, and $5,000 for his invention of a new way of transposing conductors in large generators. **A. B. Drought** (AM '51), professor at Marquette University, was one of the judges for the 1960 award. Mr. Ringland has served on the AIEE Rotating Machinery Committee (1953-60).

S. A. Schelkunoff (M '34, F '51), assistant vice-president of Bell Telephone Laboratories, retired from the Bell System on September 1 after almost 35 years of service. Upon his retirement, Dr. Schelkunoff became a professor of electrical engineering at Columbia University. Dur-

(Continued on p. 873)

OBITUARIES

Willie Edgar Bumpas (AM '39, M '45), general electrical foreman, U. S. Bureau of Reclamation, Loveland, Colo., died August 3. He had completed 38 years of service with the Bureau on transmission lines, substations, and power plants in Wyoming and Colorado. His last assignments were on transmission lines and substations on the Colorado-Big Thompson Project. Mr. Bumpas was born December 19, 1899, in Dallas, Texas.

Agostino Dalla Verde (M '51), technical general manager, Societa Idroelettrica Piemonte, Turin, Italy, died July 8. He was born April 19, 1890, in Treviso, Italy, and in 1913 received the degree of electrical engineer from the Politecnico of Milan, Italy. During 1913-15, he was employed on measuring devices for Hartmann and Braun of Frankfurt, Germany. Mr. Verde became technical manager of the Societa Idroelettrica Piemontese-Lombarda Ernesto Breda of Milano, Italy, in 1919, where he worked on hydroelectric plants and high tension lines. In 1925, he became technical general manager of the Societa Iroelettrica Piemonte of Turin, a position he held at his death. He was in charge of designing and constructing all new plants. In 1931, he began teaching electrical engineering as a professor, first at the Politecnico of Milano and later at the Politecnico of Turin. An outstanding transmission and distribution engineer, he was recently consulting engineer to the Brazilian and Argentine power companies on their high-voltage transmission lines. Prof. Dalla Verde was president of the Electrical Engineers Society of Italy during 1957-59.

Herman Leon Wallau (AM '00, F '13), who designed the Cleveland Electric Illuminating Company power plants in Ashtabula and Avon, Ohio, died recently at the age of 83. Mr. Wallau had been an electrical engineer in the company for 45 years until his retirement in 1942. He was born January 26, 1877, in Brooklyn, N. Y., and was graduated from the Brooklyn Polytechnic Institute in 1897 with the electrical engineering degree. During 1897-99, he was employed by the Brooklyn Rapid Transit Company as an assistant in the electrical engineering office. In 1900, he went to the Westinghouse Electric and Manufacturing Company, and the following year was employed by the Cleveland Electric Illuminating Company as assistant to an electrical engineer. Mr. Wallau was advanced to electrical engineer in 1904. He designed and superintended the installation of electrical features of an 11,000-volt underground transmission system installed in 1905. This included power house step-up equipment and two substations. He subsequently acted in an advisory capacity to engineers engaged in station design, but continued in the design of conductors for all systems. He was a member of the Edison Electric Institute. Mr. Wallau served on the following AIEE Committees: Power Stations, Power Generation (1916-20, 1936-37), Electrical Machinery (1921-22), Power Transmission and Distribution (1927-29), and Protective Devices (1939-42).

Charles Robert Young (AM '07, Member for Life), retired, died recently at the age of 85. Mr. Young was born September 14, 1874, in Greensboro, Vt. He graduated from the University of Vermont in 1900 as an electrical engineer, and that year joined the Western Electric Company. Later, he was transferred to the Bell Telephone Laboratories as a member of the technical staff, from which he retired in 1933.

CONSTITUTION

of the

American Institute

of

Electrical Engineers

Adopted May 13, 1884;

Amended

Dec. 8, 1885	May 21, 1920	June 25, 1951
Sept. 27, 1892	May 15, 1925	June 23, 1952
May 15, 1894	June 26, 1928	June 15, 1953
May 16, 1896	June 23, 1930	June 27, 1955
May 21, 1901	June 24, 1935	June 25, 1956
May 21, 1907	June 21, 1938	June 24, 1957
May 21, 1912	June 27, 1945	June 22, 1959
May 16, 1916	June 23, 1948	June 20, 1960

NAME AND OBJECT

C10.010 Name of this association is the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

C10.020 Object of this association is the advancement of the theory and practice of Electrical Engineering and its allied Arts and Sciences, and the maintenance of high technical and ethical standards among its members.

MEMBERSHIP

C20.010 Membership Grades are Honorary Member, Fellow, Member, Associate Member, Affiliate, Student Associate and Student Affiliate. The term "member" (not capitalized) includes all grades, the qualifications and privileges for which are as follows:

C20.020 Honorary Members are elected by the Board of Directors from among those who have rendered meritorious service to mankind in engineering or other allied fields.

C20.030 Fellows are elected by the Board of Directors from among Members who qualify as follows:

C20.031 Technical Qualifications. The nominee must qualify as an engineer or scientist under one or more of the following categories.

a. Engineer who has attained distinction in the design, construction or operation of important electrical work or in the manufacture of electric products.

b. Educator who has attained distinction in the teaching of a major course in an electrical engineering or science curriculum approved by the Board of Directors.

c. Originator who has attained distinction by reason of inventions or original work in electrical science, arts or literature.

d. Executive who has attained distinction as an engineering executive of electrical engineering work of large scope, or by the application of electricity to important engineering projects.

C20.040 Members who qualify as follows are admitted, by application, directly to this grade or by advancement from the grade of Associate Member:

C20.041 Technical Qualifications. The applicant must qualify as an engineer or scientist under one or more of the following categories:

a. Engineer who is qualified in important electrical design, construction or operation.

b. Educator who is qualified to teach a major course in an electrical engineering or science curriculum approved by the Board of Directors.

c. Originator who has attained a standing equivalent to "a" or "b" above by inventions, original work or by proficiency in electrical engineering science, arts or literature.

d. Executive who has attained a standing equivalent to "a" or "b" above as an engineering executive of an electrical enterprise of large scope, or by the application of electricity to engineering projects.

C20.050 Associate Members who qualify as follows are admitted, by application, directly to this grade or by advancement from Affiliate grade:

C20.051 Technical Qualifications. The applicant must qualify under one of the following categories:

a. Engineer who is qualified under instruction and supervision to undertake electrical design, construction, operation or manufacture.

b. Educator who is qualified under supervision to teach electrcial subjects in a curriculum approved by the Board of Directors.

c. Scientist who is qualified under instruction and supervision to undertake research, design, instruction, operation, or manufacture in fields closely related to electrical engineering.

C20.060 Affiliates who qualify as follows, are admitted to this grade by application:

C20.061 Qualifications. The applicant must satisfy the Institute that he is interested in and capable of rendering service to electrical engineering or electrical science, in the fields of engineering, commerce, industry, law, science, medicine, journalism or arts; and that his work is so related to applications of electricity that his admission to **Affiliate** grade will contribute to the welfare of the Institute.

C20.070 Students are admitted, by application, to one of the following grades:

C20.071 Student Associates are student members enrolled in an engineering or science curriculum approved by the Board of Directors. Upon graduation, Student Associates are qualified to transfer to Associate Member grade.

C20.072 Student Affiliates are student members enrolled in curricula not qualifying under C20.071.

C20.080 Other Qualifications. Age, experience, and other qualifications for any grade of member are prescribed in the Bylaws.

C20.090 Alternate Qualifications. The Board of Directors may establish in the Bylaws alternate, but at least equivalent, qualifications for all grades of membership except Fellow.

MEMBERSHIP (CONT.)

C20.100 Office holding privileges of members, in grades other than Fellow, may be limited and are prescribed in the Bylaws.

C20.110 Voting members referred to in the Constitution are: Honorary Members, Fellows, Members, and Associate Members, and they may vote on all matters. Voting privileges of other members are prescribed in the Bylaws.

ADMISSIONS AND TERMINATIONS

C30.010 Admissions. The procedure and reference requirements for admissions and advancements to various grades of membership are prescribed in the Bylaws.

C30.011 Refusals. Admission or advancement may be refused any applicant whose character, reputation or professional conduct make him an undesirable member.

C30.020 Terminations. Memberships may be terminated, as prescribed in the Bylaws, by any of the following methods.

C30.021 Resignation. A member of any grade, whose dues and other indebtedness to the Institute have been paid, may resign his membership in good standing by written communication to the Executive Secretary.

C30.022 Expulsion. Ten or more voting members, as defined in C20.110, may prefer charges against any member, other than Honorary Member, for unethical conduct. Such charges must be sent to the Executive Secretary in writing. The Board of Directors must review these charges and, if further consideration is warranted, the accused shall be notified of the charges and permitted to present a written defense or appear before the Board in person. The procedure for handling such charges is contained in the Bylaws. If the charges are sustained, the member may be expelled, suspended or permitted to resign.

C30.023 Suspension. Members who are in arrears in dues at the end of the fiscal year are placed on the arrears list. Any member who remains in arrears for one year is placed on the delinquent list and his membership suspended.

C30.030 Reinstatement. Members who are in arrears or who have been suspended for non-payment of dues, can be reinstated by payment of indebtedness as prescribed in the Bylaws.

DUES AND FEES

C40.010 Dues and Fees. The annual dues, entrance fees, transfer fees, registration fees and publication charges, as well as the rules for payment thereof, are prescribed in the Bylaws.

C40.011 Exemption from Payment. Honorary Members are exempt from all payments of dues and fees. The Board of Directors may exempt from further payment of annual dues a member who:

a. Has paid dues for 35 years, student dues excepted.

b. Has attained the age of 70, after having paid dues for 30 years, student dues excepted.

OFFICERS

C50.010 Officers. The officers of the Institute are a President, one Vice-President for each District (District Vice-President, see C80.020), one Vice-President for each Division (Technical Vice-President, see C80.080), one Director for each Department (Department Directors, see C80.070), the Directors-at-Large, a Treasurer, and an Executive Secretary.

C50.020 Term of Office. The President and Treasurer hold office for one year, Vice-Presidents and Department Directors for two years, and Directors-at-Large for four years. The Executive Secretary is appointed by the Board of Directors for a one-year term. Each year the President, Treasurer, two Directors-at-Large, the District Vice-Presidents for half of the Districts, the Technical Vice-Presidents for half of the Divisions, and the Department Directors for half of the Departments are elected. The District Vice-Presidents from even-numbered Districts are elected in odd-numbered years and vice-versa. In the event that the number of Districts, Divisions, or Departments is odd, that fraction of the corresponding officers nearest to one half shall be elected in one year and the balance the next. The election year for a new Technical Vice-President or a new Department Director shall be established by the Board of Directors to conform with these provisions when the office is established.

C50.030 Eligibility for Reelection. The President, Vice-Presidents, and Directors may not serve 2 full terms consecutively in one office. A person may not serve more than 6 years consecutively in the offices of Vice-President and Director by election. The Treasurer may not serve more than 4 years consecutively.

C50.040 Partial Terms. Vacancies for unexpired terms are filled by election by the Board of Directors. A vacancy in the office of President is filled by the election of a member of the Board of Directors. A vacancy in the office of District Vice-President, or a partial term created by the formation of a new District, is filled by election from candidates named by the Executive Committee of the District concerned. A vacancy in the office of Technical Vice-President or Department Director is filled by election from candidates named by the Division or Department concerned.

C50.050 Compensation. No officer shall receive, directly or indirectly, any salary or fees from the Institute either as an officer or in any other capacity, unless authorized by the Board of Directors.

C50.060 Business Affiliations. No officer may be interested, directly or indirectly, in any contract relating to the operations conducted by the Institute, nor in any contract for furnishing supplies to the Institute, unless expressly authorized by the Board of Directors.

ELECTIONS

C60.010 Nominating Committee. The Nominating Committee is composed of voting members, as defined in C20.110, selected by and representing parts of the Institute as follows:

C60.011 Districts have one representative each.

C60.012 Technical Divisions have one representative each.

C60.013 Board of Directors has representatives not exceeding the number of the Technical Divisions.

C60.014 Secretary. The Executive Secretary of the Institute acts as Secretary of the Nominating Committee, without vote.

C60.020 Nominations. The Nominating Committee meets and nominates candidates for Institute offices according to instructions contained in the Bylaws. The committee names one candidate for each vacancy in the office of President, Treasurer, and Directors-at-Large. It includes in its slate such candidates for (a) Vice-Presidents as have been nominated by the Executive Committees of the Districts concerned, (b) Vice-Presidents as have been nominated by the Technical Divisions concerned, and (c) Directors as have been nominated by the Departments concerned. If a District, Division, or Department fails to nominate a candidate for Vice-President or Director, the Nominating Committee nominates a candidate from the unit concerned. Additional nominations for any office may be made by written petition of twenty-five or more voting members, in accordance with rules set forth in the Bylaws. For the office of District Vice-President, the petitioners must be from the Districts concerned.

C60.021 Candidates for any office must hold a grade of membership which entitles them to serve if elected.

C60.030 Ballots. The Executive Secretary mails ballots to eligible voting members in accordance with the Bylaws. A secret ballot must be used in case there is a contest for any office. In the case of a contest for the office of District Vice-President, only the members of the District concerned are eligible to vote.

C60.040 Tellers Committee. The President appoints a Tellers Committee as prescribed in the Bylaws. Other members may be added to the Tellers Committee by petition of 20 voting members, as defined in C20.110. The Tellers Committee meets and certifies the results of the election ballot and prepares an election report. The sealed report must be filed with the Executive Secretary for announcement at the Annual Meeting of the Institute.

MANAGEMENT

C70.010 Board of Directors. The Board of Directors consists of the President, the two surviving Past-Presidents most recently retired from that office, the Vice-Presidents, the Directors and the Treasurer. The Executive Secretary of the Institute is the Secretary of the Board of Directors, without vote.

C70.011 Board Duties. The Board of Directors shall manage the affairs of the Institute. Without limiting its powers, the Board acts as follows:

a. Directs the affairs of the Institute, either itself or through its officers, departments, committees or representatives.

b. Controls the care, appropriation and investment of all funds of the Institute.

c. Acts upon the election of Honorary Members and Fellows and the expulsion of members and establishes the procedures for the admission, transfer and suspension of members.

d. Appoints the Executive Secretary and fixes his salary.

e. Establishes all Institute policies.

f. Adopts Bylaws to govern administration of the Institute under authority of the Constitution. The text of Bylaw changes must be furnished to the Board of Directors 10 days before the meeting at which the vote is taken.

C70.012 Board Action. The actions of the Board of Directors require a majority vote of the members present, except the election of Honorary Members which requires a unanimous vote of those present. All business of the Board of Directors requires a quorum which shall consist of a majority of the members of the Board.

C70.020 Executive Committee. The Executive Committee consists of the President, as Chairman, the Treasurer, and the Department Directors; and also one Past-President and four other members of the Board selected by the President in accordance with the Bylaws. The Executive Secretary of the Institute acts as Secretary of the Committee, without vote. The Board of Directors may delegate duties to the Executive Committee, which acts in its behalf between Board meetings.

C70.030 President. The President has general supervision of the affairs of the Institute, under the direction of the Board of Directors, and has the following specific duties:

C70.031 Presiding Officer. The President presides at the Annual Meeting of the Institute and at all meetings of the Board of Directors at which he is present. In the absence of the President, the senior member of the Board presides at these meetings. The senior Board member is the Board member who has served longest on the Board. In case of equal service, the one who has been a member of the Institute the longest is considered the senior member.

C70.032 Presidential Address. The President shall deliver an address at the Annual Meeting of the Institute. In the absence of the President, the senior member of the Board will present the address.

C70.033 Presidential Appointments. The President appoints the chairmen and members of the Departments, Divisions and standing committees except as provision may be made in the Constitution or Bylaws. The power to make specific appointments within a Department may be delegated to an appropriate chairman or committee of the Department, or certain chairmen, other officers or members of any Department, or Division thereof, may be elected by the appropriate members. The President also appoints special committees. He is an ex-officio member of all committees.

C70.040 District Vice-Presidents supervise the activities within their respective Districts and maintain liaison between the Board of Directors and the District organization, as detailed in the Bylaws.

C70.050 Technical Vice-Presidents supervise the technical activities within their respective Divisions and

maintain liaison between the Board of Directors and the members of the Institute with regard to their technical interests as detailed in the Bylaws.

C70.060 Department Directors are responsible for the operation of their respective Departments, in accordance with the policies established by the Board of Directors. Their powers and duties are further detailed in the Bylaws.

C70.070 Directors-at-Large shall participate in the activities of the Board of Directors. They may be appointed as chairmen or members of standing or special committees, and are not ineligible, because of their position, for election by the Board of Directors to fill unexpired terms of any other officer of the Institute. If any Director-at-Large is so elected, he may, at the option of the Board of Directors, retain also his status and term of office as a Director-at-Large. The powers and duties of Directors-at-Large may be further detailed in the Bylaws.

MANAGEMENT (CONT.)

C70.080 Executive Secretary. The Executive Secretary serves as the executive officer of the Institute under the direction of the President and the Board of Directors. He has supervision of the Headquarters personnel and is responsible for the accounts and records of the Institute. His entire time must be devoted to the affairs of the Institute, unless otherwise authorized by the Board of Directors. His duties are detailed in the Bylaws.

C70.090 Treasurer. The Treasurer is responsible for the disbursement of the Institute funds under the direction of the Board of Directors and the appropriate control of a standing committee of the Board. He must prepare the annual report of the finances of the Institute. His duties are detailed in the Bylaws.

C80.010 Organization. The activities of the Institute are carried on through departmental and regional organizations. The departmental functions are divided among boards, committees, groups, and representatives, combined into Divisions and Departments with the assistance of Headquarters staff under the direction of the Executive Secretary. The regional functions are distributed among Districts, Sections, Section Groups, Branches, and Chapters. The organization and functions of these units are set forth in the Bylaws. A general description of these various units is as follows:

ORGANIZATION

C80.020 Districts. The territory of the United States, Canada, and Mexico is divided into Districts. The boundaries of the Districts, as defined in the Bylaws, are established by the Board of Directors. Each District is represented on the Board of Directors by a Vice-President, who appoints a District Secretary. Each District has a District Executive Committee, the composition, duties and meetings of which are prescribed in the Bylaws.

C80.030 Sections. The territorial limits for the formation of Sections are confined to the United States, Canada, and Mexico. All members having mailing addresses in the territory of a Section belong to that Section only. The rules for the formation, operation and dissolution of Sections are contained in the Bylaws.

C80.031 Subsections. A Section may form one or more Subsections within its territory, as prescribed in the Bylaws.

C80.035 Section Groups. The members of a Section having a common interest in any phase of Institute activity may establish a Section Group to further that activity, as provided in the Bylaws.

C80.041 Overseas Chapters may be formed in any country outside the territorial limits specified in C80.030 for the formation of Sections, as prescribed in the Bylaws.

C80.045 Local Honorary Secretaries may be appointed by the President to represent the Institute in foreign countries. Such appointments are for a period of two years.

C80.050 Student Branches may be formed at educational institutions as prescribed in the Bylaws.

C80.060 Standing Committees. The President appoints standing committees, some of which report directly to the Board of Directors, while others are grouped into Departments and Divisions. The Board of Directors may create, rearrange or discontinue standing committees, as prescribed in the Bylaws. The term of members on standing committees terminates at the end of the administrative year for which they are appointed, unless otherwise specified in the Constitution or Bylaws.

C80.065. Special Committees. The President may appoint special committees to carry out non-recurring activities not within the scope of the standing committees or Departments. The term of members on special committees terminates at the end of the administrative year for which they are appointed, unless otherwise specified in their appointments.

C80.070 Departments. Most of the standing committees are grouped into Departments. The activities of the Institute are divided among the Departments, each Department being responsible for a specific phase of the Institute's work.

C80.075 Divisions. The Department that handles the preparation and presentation of technical papers and the work of the technical committees is divided into Divisions to correspond to the different branches of electrical engineering.

C80.080 Institute Groups. The members of the Institute having an interest in the activities of a standing committee may establish an Institute group directed toward furthering the activities of the committee as provided in the Bylaws.

C80.090 Representatives on intersociety or joint committees or boards are appointed by the President or the chairmen of Departments to which they are assigned, as prescribed in the Bylaws.

MEETINGS AND PUBLICATIONS

C90.010 Annual Meeting. The date and location of the Annual Meetings of the Institute are determined as prescribed in the Bylaws. Notice of the Annual Meeting must be mailed to all voting members, as defined in C20.110, at least 10 days in advance of the meeting. A quorum at the Annual Meeting, in person or by proxy, shall consist of not less than 100 voting members, as defined in C20.110.

C90.011 Annual Report. A report of the activities of the Institute for the past fiscal year must be submitted by the Board of Directors at the Annual Meeting. A copy of the report must be filed with the Institute records and an abstract entered in the minutes of the Annual Meeting.

C90.012 Annual Election. The results of the membership vote for officers for the ensuing year must be announced at the Annual Meeting and the successful candidates declared elected.

C90.013 Business Meeting. Any business matters of the Institute may be brought before and transacted at the Annual Meeting.

C90.020 Meetings are held each year at dates and places as prescribed in the Bylaws for the purpose of presenting and discussing papers and reports. Business pertinent to the Institute may be transacted at these meetings, except that matters of organization and policy may be brought up only for discussion and may be referred to the Board of Directors.

C90.030 Proxies. A member entitled to vote at a business meeting, as defined in C20.110, may vote by proxy assigned by the member himself, and filed with the Executive Secretary as prescribed in the Bylaws.

C90.040 Parliamentary Procedures at meetings of the Institute and the Board of Directors shall be governed by the Sturgis Standard Code of Parliamentary Procedure.

C90.050 Publications. The Institute sponsors publications as specified in the Bylaws.

C90.070 Fiscal Year. The fiscal year of the Institute begins on May 1.

C90.080 Administrative Year. The administrative year of the Institute begins on August 1.

AMENDMENTS

C100.010 Amendments to this Constitution may be proposed not later than February 15 for action that year as follows:

C100.011 Resolution by the Board of Directors.

C100.012 Petition by 100 or more voting members, as defined in C20.110, to the Executive Secretary.

C100.020 Counsel Review. An opinion of legal counsel, that the proposed amendments are in accordance with the laws under which the Institute is organized, must be secured before vote by the membership.

C100.030 Ballot Vote. A copy of the amendment must be mailed with a letter ballot to all members entitled to vote, as defined in C20.110, not later than April 1 for action that year. Ballots must be returned to the Executive Secretary not later than June 1 to be counted.

C100.040 Tellers Committee. The Tellers Committee appointed by the President for the election of officers shall also certify and report the ballots on any amendments as specified in C60.040.

C100.050 Adoption. Amendments that receive 75 percent of the total vote become a part of the Constitution, provided the total vote is not less than 20 percent of the total number of voting members as defined in C20.110. The effective date of any amendment is on August 1 after the adoption.

C100.060 Printed Copies. The amendments must be distributed to the membership in printed form.

BYLAWS of the American Institute of Electrical Engineers

(Adopted by the Board of Directors April 22, 1904, and amended during the past administrative year on June 24, 1960.)

The Constitution authorizes the adoption of Bylaws as follows:

C70.011 f. Adopts* Bylaws to govern administration of the Institute under authority of the Constitution. The text of the Bylaws changes must be furnished to the Board of Directors 10 days before the meeting at which the vote is taken.

*(The Board of Directors—Ed.)

MEMBERSHIP

B20.010 Membership Grades are defined in C20.010.

B20.011 Abbreviations may be used as follows by Fellows, Members, Associate Members, Affiliates, and Honorary Members indicating their grade of membership in the Institute.

Honorary Member, Hon. Mem. AIEE	Member, Mem. AIEE
Fellow, Fel. AIEE	Associate Member, Assoc. Mem. AIEE
	Affiliate, Affil. AIEE

The term "member" (when printed without a capital), where used herein includes Fellows, Members, Associate Members, Affiliates, and Honorary Members.

B20.012 Designation of membership may be used by a member of the Institute for purely personal purposes only. When used, the designation shall include his membership grade.

Membership designations may not be used by a corporation, association, firm, or other organization even though its representatives or staff are members of the Institute.

B20.013 Symbols. The officially issued badge is the only Institute symbol which a member is entitled to use personally. Symbols such as imprints of badge design may be used only in connection with Institute business.

Improper use of Institute symbols or badges or claims made by nonmembers that they belong to the Institute should be called to the attention of the Executive Secretary. The Executive Secretary thereupon investigates the facts and advises the Board of Directors.

B20.014 Rights and Privileges of each member are personal and are not transferable by his own act or by operation of law.

B20.020 Honorary Members are defined in C20.020.

B20.021 Election of Honorary Members is by unanimous secret ballot of the Board of Directors present at a regular meeting. The election of an Honorary Member shall be deemed invalid if acceptance is not received within 6 months from the date of his election. Nominees for Honorary Member are normally recommended by the Honors Advisory Committee but may be proposed to the Board of Directors in writing by not less than 10 members.

Proposals for the election of Honorary Members do not come under the review of the Board of Examiners and the routines set up by the Board of Examiners do not apply to the nominees proposed for the grade of Honorary Member.

Proposals for Honorary Membership made directly to the Board of Directors are referred to the Honors Advisory Committee, and the Board takes action after that Committee has had an opportunity to make recommendations.

B20.030 Fellows are defined in C20.030 and are elected by the Board of Directors from those Members whose outstanding work in electrical science or electrical engineering in any field is brought to the attention of the Board of Examiners by five or more Fellows or Members who submit data that in the opinion of the Board of Examiners is sufficient to substantiate the importance of the accomplishment and warrant the issuance of the citation and conferring of the honor. Transfer to Fellow grade may not be obtained by application.

B20.031 Technical Qualifications are stated in C20.031.

B20.032 Age and Experience Requirements. A Fellow shall at the time of election be at least 40 years of age. He shall have had at least 15 years of active experience, and shall have been in good standing in Member grade for at least 10 years immediately prior to the date of proposal for election to Fellow. As one measure of accomplishment under C20.031 "a" or "b" he shall have been in responsible charge of such work for at least 5 years.

B20.033 Cognate Society. A person who, at the time of admission to the grade of Member, held in good standing in a cognate electrical engineering society of national scope in any country a grade of membership for which the qualifications indicate a standing equivalent to that required for the grade of Member herein, may have such years of prior membership in that equivalent grade, to a maximum of 9, considered as a part of the requisite 10 years in Member grade.

B20.040 Members are defined in C20.040.

B20.041 Technical Qualifications are defined in C20.041.

B20.042 Age and Experience Requirements. At the time of admission or advancement to the grade of Member, the applicant shall be at least 30 years of age and actively engaged in the electrical field—temporary unemployment excepted. He shall have had at least 10 years of active practice of the profession in one or a combination of several branches of the electrical field, indicative of growth in competency and achievement in that field and of a character satisfactory to the Board of Examiners. As one measure of accomplishment under C20.041 "a" or "b" he shall have been in responsible charge for at least 2 years. Graduation from an engineering or science curriculum approved by the Board of Directors may constitute 4 years of this requisite 10 years of practice. Graduation from an engineering or science curriculum not approved by the Board of Directors may be given such credit as is delineated in the Code of Practice of the Board of Examiners.

In addition, to qualify under C20.041 he shall have been in good standing in the grade of Associate Member for at least 2 consecutive years immediately prior to the date of application for the grade of Member, or as an alternative he shall have had at least 3 additional years in active practice during which time he shall have been in responsible charge of work as described in C20.041.

B20.043 Cognate Society. A person who holds in good standing in a cognate engineering society of national

scope in any country a grade of membership for which the qualifications indicate a standing equivalent to Member herein, shall have such membership considered as fulfilling requirements for Member grade in C20.041.

B20.050 Associate Members are defined in C20.050.

B20.051 Technical Qualifications are stated in C20.051.

B20.052 Age and Experience Requirements. At the time of admission to the grade of Associate Member, the applicant shall be at least 21 years of age. To qualify under C20.051, an applicant shall have had 6 years of increasingly important engineering or scientific experience indicative of growth in competence and achievement. Graduation from an engineering or science curriculum approved by the Board of Directors will be considered the equivalent of the requisite experience; graduation from an engineering or scientific curriculum not approved by the Board of Directors may be given such credit as is delineated in the Code of Practice of the Board of Examiners.

B20.060 Affiliates are defined in C20.060.

B20.062 Age Requirement. At the time of admission to the grade of Affiliate, the applicant shall be at least 21 years of age.

B20.070 Student Members are defined in C20.070.

B20.100 Office-Holding Privileges. Fellows, Members, and Associate Members shall be equally entitled to all the rights and privileges of the Institute, excepting that Fellows only shall be eligible for the office of President; and Fellows and Members only shall be eligible for the offices of District Vice-President, Technical Vice-President, Department Director, Director-at-Large, and Treasurer.

Affiliates shall have all the rights and privileges of Institute membership, except that their right to vote shall be limited to voting in Section elections and on Section matters, and their right to hold office shall be limited to those Section offices that do not require the office holders to participate in Institute General and District Meetings as Section delegates or representatives.

Honorary Members shall be entitled to the rights and privileges of the Institute other than holding office therein.

B20.110 Voting Members are defined in C20.110.

B30.010 Admissions. The procedure and reference requirements for admissions and advancements to various grades of membership are as follows:

a. Applications for admission to the Institute or for transfer to a higher grade shall be made on a form provided by the Institute, and shall embody a full record of the general technical education of the applicant and of his professional career. Applicants shall refer to the required number of members of the grades specified in "b". Except in the case of student members applying for admission to Associate Member or Affiliate grades, each of these references shall be requested by the Executive Secretary to fill out a prescribed confidential form for consideration by the Board of Examiners.

Applications for transfer may be made from the grade of Associate Member to the grade of Member or from the grade of Affiliate to the grade of Associate Member.

b. References. Applicants for admission or transfer to any grade of membership shall give reference, except as otherwise provided herein, as follows:

For the grade of Member—five Fellows or Members
For the grade of Associate Member—four Fellows, Members, or Associate Members
For the grade of Affiliate—three Fellows, Members, Associate Members, or Affiliates

Applications for admission or transfer are acted upon by the Board of Examiners after replies are received from references. In the event of failure to receive replies from the required number of references, as indicated above, or if more information is required, the applicant is called upon for additional references or information. The Board of Examiners is the judge of the adequacy of the reference and the information.

Should an applicant for admission or transfer certify that he is not personally known to the above specified number of AIEE members, who are sufficiently familiar with the applicant's experience to justify him in using their names as references, the Board of Examiners may accept, for the deficiency, other references, preferably engineers of standing in the profession.

c. Curricula. In making recommendations for elections and transfers based upon the curricula of educational institutions, the Board of Examiners shall limit itself, to the extent applicable, to curricula approved by the Institute. In addition, the Board of Examiners may propose credits for graduation in other curricula in engineering or science which justify some recognition toward membership requirements. Any changes in such credits are submitted to the Board of Directors for approval before becoming effective.

An advanced degree for graduate work in engineering or science from an educational institution having undergraduate curricula approved by the Institute, is considered the equivalent of graduation from an approved engineering or science curriculum, without respect to the curricula of the institution at which the undergraduate training was received.

d. Professional Engineer License. A license as a Professional Engineer issued by a legally constituted authority, whose requirements for licensing are approved by the Institute, is considered as evidence of experience and professional stature on the part of the applicant. Four years of the experience upon which the professional license is predicated are counted toward meeting the requirements in experience, even though acquired in some other engineering field than the electrical.

e. Student Admissions. The student applicant must devote at least 30 percent of full time to studies under the supervision of the institution in which he is registered.

Endorsement of each student applicant by a voting member of the Institute is required. The application is then submitted to the Board of Examiners for action.

The duration of student membership is contingent upon the following:

1. Upon graduation the student member becomes eligible for admission to either the Associate Member grade or the Affiliate grade. If the fiscal year ends (April 30) within 6 months or less after the date of graduation, student membership may be continued for 1 additional fiscal year.

2. Where the age of 21 has not been reached on,

ADMISSIONS AND TERMINATIONS (CONT.)

or prior to, the date of graduation, student membership can be renewed to the end of that fiscal year in which this age is attained.

3. In no case shall student membership extend beyond a period of 7 years.

Student members in good standing may be admitted to either the Associate Member grade or the Affiliate grade upon written request, certification of graduation, and character report.

Certification may be made by the Student Branch Counselor, an administrative officer of the school, or by the student, by means acceptable to the Board of Examiners.

f. Student Transfers. A student member who is a graduate of an engineering or science curriculum approved by the Institute and who makes application for transfer to the Associate Member grade before expiration of his student membership shall be considered as having met the qualifications under C20.051 of the Constitution.

g. Merit. The Board of Examiners considers applications solely upon their merits.

h. Other Grades. An applicant for admission to the Institute, who in the judgment of the Board of Examiners is not eligible for the grade applied for, but is eligible for admission to a lower grade, may be so notified and be given the opportunity of changing his application accordingly.

i. Objection to the admission or transfer of any candidate to any grade must be accompanied by reasons for such objection. All such statements are treated as confidential.

j. Effective Date. The privileges attached to membership in the Institute are not accorded to applicants for admission until they have been duly elected, and have paid their entrance fees and current dues.

B30.020 Terminations are effected as in C30.020 through C30.023.

A member whose membership shall terminate for any cause has no right or interest in any property of the Institute or any claim or privilege in or against the Institute or pertaining thereto.

B30.021 Resignations are effected as in C30.021.

Any resignations received by the Executive Secretary not later than June 1 of any year (September 1 in the case of members residing outside of the United States, Canada, and Mexico), may, at his discretion, be considered as having been received as of May 1 preceding. A resignation received after June 1 (or September 1 for non-resident members) involves payment of dues for that portion of the fiscal year ending with, and including, that month in which the resignation is received.

B30.022 Expulsions are effected as in C30.022.

A Fellow, Member, Associate Member, or Affiliate whose expulsion has been properly requested as set forth in C30.022, is notified in writing, mailed to his address of record in the Institute. He has the right to present a written reply and to appear for a hearing, in person or by duly authorized representative, before the Board of Directors, of which meeting he is notified at least 20 days in advance. Within 140 days after such hearing, the Board of Directors shall finally consider the case and, if in the opinion of the Board of Directors the charges have been sustained, the accused may be expelled, or suspended for such period as the Board may determine, or he may be permitted to resign.

B30.023 Suspensions are effected as in C30.023.

Any member whose current year's dues remain unpaid as of October 1, and who has been mailed *Electrical Engineering* for the months May through October, is removed from the publications mailing list. Upon subsequent payment of his dues, he will be restored to the publications mailing list and receive all issues from that date on. Issues during this interval are considered forfeited; however, upon request, they will be supplied if available. Any member remaining in arrears on the following May 1 is placed on the Suspended List, and is debarred from enjoying membership privileges until reinstated. At the first meeting of the Board of Directors in the fiscal year, the Executive Secretary submits to the Board of Directors a list of the delinquents, for its action thereon.

B30.030 Reinstatements are effected as in C30.030.

Any applicant for readmission first pays a reentry fee, which shall be considered waived if the applicant had resigned in good standing. This reentry fee, which shall be considered as satisfying all past dues indebtedness shown on the Institute's records, is equal to one-half of the current rate of dues for the grade of readmission. Upon satisfying the above, the applicant may be readmitted after review of his professional record by the Board of Examiners. The applicant then renews his membership privileges after payment of pro rata dues for the year readmitted.

Any applicant or member in good standing may at any time reinstate his original date of election or transfer by payment of dues at the currently prevailing rate of his grade of membership for the period of his lapsed membership.

Retroactively paid years of membership in the Member grade shall not be considered as forming any part of the 10 consecutive years' requirement for transfer to the grade of Fellow.

DUES AND FEES

B40.010 Entrance Fees.

Entrance fees payable on admission to the Institute are as follows:

Member	$15
Associate Member	$10
Affiliate	$10

B40.011 Waiver of Entrance Fee may apply to applications for admission from student members, graduate students, or from members of other engineering societies with whom there is an approved reciprocal agreement.

a. A student member, upon admission to the Institute, is not required to pay the entrance fee when his application is submitted in accordance with B30.010. This applies to student members of reciprocating engineering societies, except that eligibility is restricted to those being admitted to the Associate Member or Affiliate grades.

b. A Graduate Student in an institution having approved curricula is not required to pay the entrance fee upon admission to the Associate Member grade, provided he holds a bachelor degree from a school similarly approved and was not a

student member at the time he entered upon his graduate work.

c. Agreement With ASME. A member of the American Society of Mechanical Engineers, upon admission to the Institute to an equivalent or lower grade, is not required to pay the entrance fee, provided a formal application is filed with all necessary qualifications set forth for the grade of membership applied for.

d. Agreement With IEE. A Corporate Member or Graduate of the Institution of Electrical Engineers (Great Britain) in good standing is not required to pay the entrance fee for admission to an equivalent grade of membership in the American Institute of Electrical Engineers provided the applicant has taken up permanent residence in the United States of America, and makes application within 12 months following the established date of his permanent residence.

e. Agreement with IRE. (Effective January 1, 1961). A member of the Institute of Radio Engineers, by virtue solely of his qualifications submitted to that Society, may join AIEE in an equivalent grade of membership, up to but not including Fellow, without payment of entrance fee and the basis of equivalent grades shall be understood to be as follows:

AIEE	*IRE*
Member	Senior Member
Associate Member	Member
Affiliate	Associate

B40.012 Transfer Fees

a. Advancement in Grade of membership requires the payment of a transfer fee. This applies also to anyone seeking advancement in grade, when applying from a reciprocating society.

b. Transfer Fees payable upon advancement in membership grade are as follows:

Affiliate to Associate Member Grade . . .	$5
Associate Member to Member Grade . .	$5

B40.013 Annual Dues

a. Persons Other Than Student Applicants elected after any portion of the fiscal year shall have expired, shall pay dues pro rata for the unexpired months of that fiscal year.

b. Annual Dues payable in advance at the beginning of each fiscal year, as defined in C70.070, are as follows:

Fellow	$25
Member	$20
Associate Member	$20
Affiliate	$20
Student Member	$ 5

c. The Executive Secretary shall each year send a notification accompanying the annual dues bill to each member who has paid dues for 35 years or who has reached the age of 70 after having paid dues for 30 years, that he is eligible for exemption from future annual dues and that his name has been enrolled upon the records as a "Member-for-Life." Annual dues bills shall continue to be issued until the member concerned has indicated his acceptance of exemption from the further payment of dues.

d. Reduction of Dues is authorized for an Associate Member or an Affiliate for his first 6 years of membership which shall include any prior membership in either grade or until he has attained the age of 30 years. His annual dues during this period are $15.

e. A Reduced Annual Rate of $6 per year is authorized for a member who is a graduate student in an institution having approved curricula, provided he is devoting not less than one-half of full time to graduate studies in the institution in which he is registered, and he furnishes the Institute each year with proper certification of his student status.

f. Initial Student Member dues payable with application for enrollment are:

1. Five dollars, if the application is filed at Institute Headquarters between February 1 and July 31, inclusive.

2. Two and one-half dollars, if the application is filed at any other time.

g. Renewals For Student Members are always for a full fiscal year, beginning May 1.

h. Membership Dues for students who have been admitted to the Associate Member grade, or the Affiliate grade, are payable in advance and begin when the student membership expires.

B40.014 Election Notification, accompanied by a statement of his entrance fee and dues, shall be mailed to each candidate by the Executive Secretary. A second notice of his indebtedness shall be mailed one month later to every candidate remaining in arrears in the United States, Canada, or Mexico, and 3 months later to other candidates. The Executive Secretary may, at his discretion, cancel the election of an applicant remaining in arrears 3 months after the mailing of the second notice.

B40.015 Billing

a. A bill for annual dues shall be mailed to each member on or about May 1. A minimum of three additional notices shall be sent to those remaining in arrears. The annual dues bill and each of the subsequent notices sent to those remaining in arrears shall have abstracts of pertinent Bylaws printed on the reverse side.

b. The Executive Secretary shall each year, previous to the mailing of bills for annual dues, select from the membership list the names of all Associate Members and Affiliates whose period of reduced dues, as stipuated in B40.013d, shall have terminated by May 1 of that year; and to such Associate Members and Affiliates mail bills for annual dues of $20.

c. The mailing of such bills or statements to his address of record in the Institute shall be considered a valid notice of indebtedness.

B40.016 Publication Charges

a. Electrical Engineering

1. Each member of the Institute and each student member is entitled to receive only at his regular Institute mailing address single copies of *Electrical Engineering* issues during the period covered by the payment of dues.

2. The Executive Secretary is authorized to receive from non-members prepaid annual subscriptions to *Electrical Engineering* at rate of $12.00 per year with such extra postage charge as may be required to cover mailing cost to

DUES AND FEES (CONT.)

B40.016 a 2 (cont.)

all countries to which the bulk rate of postage does not apply. Single copies may be obtained, when available, at $1.50 each. All orders for less than a full year will be charged on this basis. A discount of 25 percent will be allowed to college and public libraries. Publishers and subscription agencies may be allowed a discount of 25 percent on college and public library orders and 15 percent on all others. Non-member subscriptions are non-cancelable for portions of a year.

3. The portion of annual dues that shall be deemed applicable to a subscription of *Electrical Engineering* shall be 50 percent of the annual non-member subscription rate.

4. Student members may purchase replacement copies of *Electrical Engineering*, if available, at 25 cents each where such copies are required to replace loss caused by failure to notify the Executive Secretary of change of mailing address).

b. Bimonthly Publications

Part I—*Communication and Electronics*
Part II—*Applications and Industry*
Part III—*Power Apparatus and Systems*

1. Each member may subscribe to any one or all three of the Bimonthly publications, to be sent to his regular Institute mailing address, at the rate of $5.00 each, per year. Additional subscriptions by a member to any of these Bimonthly publications may be obtained at the non-member rate of $8.00 each, per year.

2. Each student member may elect to receive one of the Bimonthly publications at the rate of $1.00 per year. The other two are also available to student members at the rate of $2.50 each, per year.

3. The Executive Secretary is authorized to receive from non-members prepaid subscriptions to one or more of the three Bimonthly publications at the rate of $8.00 each, per year, with an extra postage charge sufficient to cover mailing costs to all countries to which the bulk rate of postage does not apply. A discount of 25 percent from the subscription price of $8.00 will be allowed to college and public libraries. Publishers and subscription agencies may be allowed a discount of 25 percent on college and public library subscriptions and 15 percent on all others. Single copies may be obtained, when available, at $1.50.

c. Transactions

Part I—*Communication and Electronics*
Part II—*Applications and Industry*
Part III—*Power Apparatus and Systems*

1. Each member of the Institute and each student member is entitled to subscribe to one or two parts of the Transactions at the advance subscription rate of $4.00 each per year, or to all three parts at the rate of $10 per year, when mailed to his regular Institute mailing address.

2. The Executive Secretary is authorized to receive from non-members advance subscriptions to one of the parts of the Transactions at the rate of $8.00 per year, two parts at the rate of $15.00 per year, and three parts at the rate of $20.00 per year, with such extra postage charge as may be required to cover the mailing cost to all countries to which the bulk rate of postage does not apply. Discounts of 25 percent from these prices may be allowed to college and public libraries whether orders are placed directly or through subscription agencies; and of 15 percent to publishers and subscription agencies for other than college and public library subscriptions.

ELECTIONS

B60.010 Nominations. Officers of the Institute, as defined in C50.010, are nominated and elected for terms as specified in C50.020, in accordance with the following procedures:

The Nominating Committee is made up of representatives of the Districts, Technical Divisions, and Board of Directors, as specified in C60.010, C60.011, C60.012, and C60.013.

B60.011 District Members of Nominating Committee. Each District has one representative on the Nominating Committee. During September of each year, the Secretary of the Nominating Committee shall notify the Chairman and Secretary of the Executive Committee of each District that, by December 15 of that year, each District should select a representative to serve as a member of the AIEE Nominating Committee, and an alternate to serve if the representative is unable to attend the meeting of the Nominating Committee.

B60.012 Technical Division Members of Nominating Committee. During September of each year, the Secretary of the Nominating Committee shall notify the Chairman and Secretary of each Technical Division that, by December 15 of that year, each Technical Division should select a representative to serve as a member of the AIEE Nominating Committee, and an alternate to serve if the representative is unable to attend the meeting of the Nominating Committee.

B60.014 Secretary of Nominating Committee is as defined in C60.014.

B60.020 Procedure for Nominations. The Secretary of the Nominating Committee shall give the members not less than 10 days' notice of the first meeting of the Committee, which shall be held not later than February 15. At this meeting, the Committee shall elect a Chairman and shall proceed to make up a ticket of Nominees for the offices to be filled at the next election.

During September of each year, the Secretary of the Nominating Committee shall notify the following groups that nominations, as designated, should be received by the Secretary of the Nominating Committee by December 15th of that year:

a. The Chairman and Secretary of the Executive Committee of each District, in which there will be during the year a vacancy in the office of District Vice-President, a nomination for a District Vice-President, made by the District Executive Committee;

b. The Chairman and Secretary of each Technical Division, in which there will be during the year a vacancy in the office of Technical Vice-President, a nomination for a Technical Vice-President, made by the Technical Division Committee;

c. The Chairman and Secretary of each Department, in which there will be during the year a vacancy in the office of Department Director, a nomination for Department Director made by the Department.

ELECTIONS (CONT.)

B60.022 Independent Nominations. Additional nominations for any office may be made in accordance with C60.020. Petitions, proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C60.020, shall be received by the Executive Secretary not later than March 15 of each year. These nominations shall be included on the ballot if such candidates are eligible.

B60.023 Emergency Resulting from Death or Incapacity of President-Nominee, the President-Elect, or the President. In the event of death or incapacity of the President-Nominee, President-Elect, or President, it will be assumed that a vacancy exists in such office, which will be filled by the action of the Board of Directors.

B60.030 Ballots. On or before April 15 of each year, the Executive Secretary shall mail to all qualified voters an official ballot on which are to be listed all eligible candidates, nominated as provided in C60.020. The candidates of the Nominating Committee shall be appropriately designated as such. Any nominee may, prior to the printing of the ballots, withdraw his name by written request to the Executive Secretary, whereupon that fact shall be suitably indicated upon the ballot.

In the event of no contest for any office, the slate of the Nominating Committee, in the form of a ballot, and having a reference to the biographies of the candidates in *Electrical Engineering*, shall be mailed to the voting members.

B60.031 Methods for Balloting. The voting for each office shall be restricted to the nominees for that office as printed on the ballot. When there is a contest for any office, the ballot shall be accompanied by an envelope on which shall be printed the title of the Institute, the name and address of the Executive Secretary, and the words, "Official Voting Envelope —Enclosing a Ballot Only." The names of the nominees shall be written, printed, or otherwise marked on a single ticket or ballot, which shall be enclosed in a sealed unmarked, and unidentified inner envelope of any suitable character, which shall in turn be enclosed either in the "Official Voting Envelope" (received from the Executive Secretary), or any other envelope, marked on its face, "Non-Official Voting Envelope—Enclosing a Ballot Only." The outer envelope of either class shall be identified by the name of the sender, shall be sealed, and in order to be counted, shall reach the Executive Secretary not later than the first day of June.

B60.040 Tellers Committee Appointment. The President, during the month of May, shall appoint, subject to the approval of the Board of Directors, a Tellers Committee. This Committee shall be selected from voting members. Members of the Board of Directors, members of the Nominating Committee or their alternates, or any nominee appearing on the ballot, or petitioners of a nominee, are ineligible to act as tellers. Other appointees as tellers are authorized by written petition delivered to the Executive Secretary on or before the first day of May. A minimum of 20 signatures of voting members is required. A petitioner is eligible to sign only one petition. Each signer shall have the qualifications of a teller.

B60.041 Tellers Committee Report. The Tellers Committee shall meet at the office of the Institute as soon after the first day of June as possible and prepare an Election Report; one copy filed with the Executive Secretary, the other copy with the Chairman of the Tellers Committee and kept sealed until presented to the presiding officer of the ensuing Annual Meeting. In the absence of the Chairman of the Committee, the Executive Secretary will present his copy of the Election Report. The Tellers' Election Report shall give the sum total of the ballots received, and shall designate this total as a vote for the entire slate of officers where there are no alternative candidates. Only in the case of a contest shall an individual count be made. The presiding officer at the Annual Meeting shall cause the report to be read, and shall declare those duly elected in accordance with the results of the vote as presented in the report.

MANAGEMENT

B70.020 The Executive Committee shall consist of the officers mentioned in C70.020, the chairmen of the Planning and Coordination Committee and Finance Committee, and two other members of the Board of Directors selected by the President.

B70.050 Executive Secretary

B70.051 Under the direction of the President and Board of Directors, the Executive Secretary serves as the executive officer of the Institute. As such, he exercises direct supervision and authority over, and is responsible for engaging and directing all personnel employed in providing Institute Services to Departments, Committees, and the membership.

B70.052 He acts as Secretary to the Board of Directors, the Executive Committee, the Planning and Coordination Committee, and the Nominating Committee, and all business meetings of the Institute, participating in the deliberations without vote.

B70.053 He is responsible for the maintenance of the records and accounts of the Institute, and for all official correspondence pertaining to them.

B70.054 He is responsible for the collection of all funds due the Institute and their allocation under authorization of the Board of Directors and supervision by the Finance Committee and the Treasurer.

B70.055 As authorized by the Board of Directors, and under the direction of the Finance Committee, the Executive Secretary certifies to the appropriateness and correctness of all bills submitted for payment from funds of the Institute.

B70.056 He is custodian of the quarters, property, and equipment owned and used in conducting the business of the Institute.

B70.057 He attends such meetings of the Institute, its units, and related bodies as may be required in the discharge of his duties.

B70.058 He makes such reports to the Board of Directors as may be required by the Board.

B70.060 Treasurer

B70.061 Reports to the Board of Directors on the receipts and expenditures;

a. As an Annual Financial Report

b. As a Cash Statement

MANAGEMENT (CONT.)

B70.062 Reports to the Board of Directors on the financial affairs in the form of a balance sheet at least four times a year.

B70.063 Reviews the deposit records of moneys as reported by the Executive Secretary.

B70.064 Approves the expenditures of moneys as recommended by the Finance Committee.

B70.065 Advises on the over-all financial program of the Institute, including the budget.

B70.066 Acts ex-officio as an officer of the Volta Fund, with authority for control of investments.

ORGANIZATION

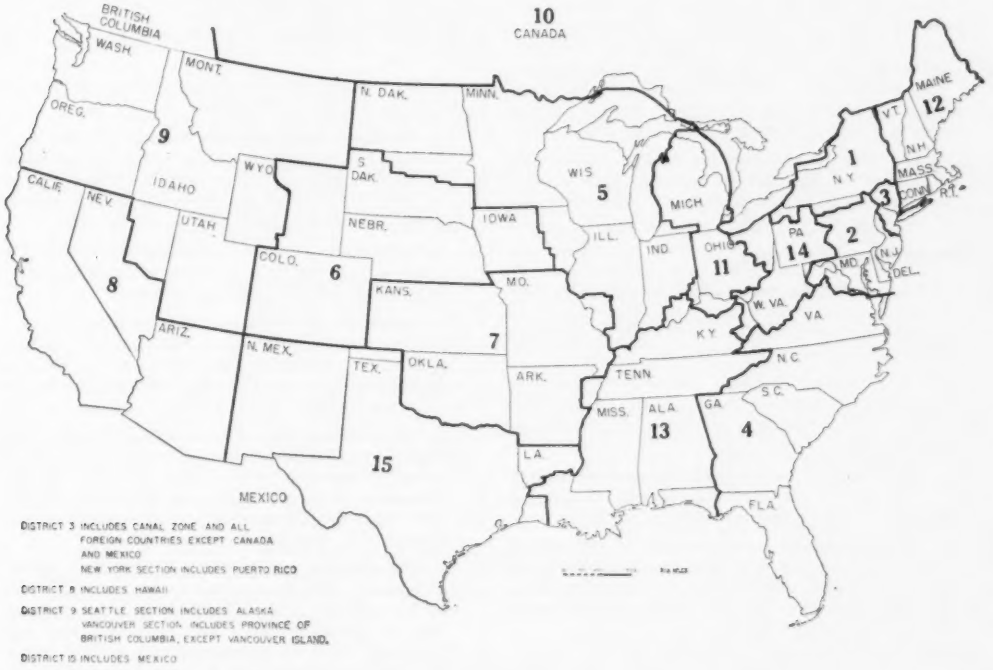
B80.010 Organization. The activities of the Institute are carried on through departmental and regional organizations. The departmental functions are divided among boards, committees, and representatives, grouped into Divisions and Departments, with the assistance of the Headquarters Staff under the direction of the Executive Secretary. The regional functions are distributed among Districts, Sections, Subsections, Branches, and Chapters. The organization and functions are set forth in these Bylaws. A general description of these various units is as follows:

B80.020 Districts. The territory of the United States, Canada, and Mexico is divided into Districts. The boundaries, as defined in these Bylaws are established by the Board of Directors. Each is represented on the Board of Directors by a District Vice-President who appoints a District Secretary. Each has a District Executive Committee, the composition, duties, and meetings of which are prescribed in these Bylaws.

B80.021 There are **Fifteen Geographical Districts,** numbered and named as follows:

1. Empire
2. Middle Eastern
3. Metropolitan New York
4. South East
5. Great Lakes
6. North Central
7. Mid-America
8. Pacific
9. Northwest
10. Canada
11. East Central
12. North Eastern
13. South Central
14. Allegheny–Ohio Valley
15. Southwest

The territory covered by each of the 15 Districts shall be as in the accompanying map.



B80.022 District Executive Committee. Each District has a District Executive Committee, the composition and operation of which are as follows:

a. Composition. The District Executive Committee consists of the District Vice-President, the District Secretary, the Chairman and one other representative from each Section, the Chairman of the District Prize Papers Committee, the Chairman of the District Student Activities Committee, the District Representatives of the Membership Committee, Sections Committee, and Technical Operations Department, the Past District Vice-President (first meeting only), and the Chairman of each Subsection (at the invitation of the District Vice-President).

b. Appointments. The District Vice-President appoints the District Secretary and the Chairman of the District Prize Papers Committee. The District Representatives of the Membership Committee, Sections Committee, and Technical Operations

Department are appointed by the District Vice-President with the approval of the committee or Department concerned. The Chairman of the District Student Activities Committee is selected by the Branch Counselors of the District.

The District Vice-President appoints alternates from the cognizant Department or committee for the Chairman of the District Prize Paper Committee and the District Representatives of the Membership Committee, Sections Committee, and Technical Operations Department and approves alternates designated by the Sections for the Section Chairmen and other Section Representatives attending District Executive Committee meetings.

c. Meetings. There is one designated meeting of the District Executive Committee each year at the call of the District Vice-President. A second meeting may be held if considered desirable by the District Vice-President and the District Executive Committee. Not more than one travel allowance will be paid each year to those attending District Executive Committee meetings.

d. Travel Allowance. All members attending the designated District Executive Committee meeting receive travel allowance based on such rate per mile one way, from place of residence to meeting place, as is established by the Board of Directors.

e. Voting Privilege. The District Vice-President, the past District Vice-President, the District Secretary, the Chairman of the District Student Activities Committee, and the Chairman and one other representative of each Section are entitled to vote. The past District Vice-President is a voting member only at the first meeting of the District Executive Committee in the new administration.

f. The District Vice-President shall visit Sections and Student Branches within the District, with responsibilities as described in the District Operations Guide.

B80.023 Student Activities.

a. Cooperation Among Student Branches. In each District having three or more Branches, there is a District Student Activities Committee to facilitate cooperation among the Branches.

b. This District Student Activities Committee comprises the District Vice-President, District Secretary, and all the Student Branch Counselors in the District.

c. This Committee elects a **Chairman** from among the Counselors, not later than May 15, and transmits his name to Institute Headquarters.

d. These Chairmen are responsible to the officers of the Institute and to the Student Branches Committee, of which they become ex-officio members, for the conduct of student affairs within their respective Districts.

B80.030 Sections. The territorial limits for the formation of Sections are confined to the United States, Canada, and Mexico. All members having mailing addresses in the territory of a Section belong to that Section only.

a. A petition for the **formation of a Section** shall be signed, on a form provided by Institute Headquarters, by not less than 50 members residing within the territorial limits thereinafter prescribed. The Board of Directors may decline to authorize the formation of a Section when in its judgment such an organization would not be compatible with the interests of the Institute.

b. In the initial Section organization, only petitioners have the right to vote.

c. A Section is known as: The (name of place) Section of the American Institute of Electrical Engineers.

d. Each **Section is represented** at the Conference of Section Delegates by one official delegate.

e. Any Section may adopt for its own government such Bylaws, to be known as **"Section Bylaws,"** as it may find expedient, provided that no provision thereof is incompatible with the Constitution or the Bylaws of the Institute.

f. In addition to Institute members, Section Bylaws may provide that **other persons interested** in engineering may be admitted to membership in the Section. These members may have all the Section privileges except those of voting and holding office.

g. A Section whose membership has become 30 or less as of August 1, or a Section which shall have held less than four meetings in any fiscal year (May 1 through April 30), shall be formally advised by the Executive Secretary that, if within the next year this situation has not been materially improved, **Such Section shall become a Subsection** (or Division), effective October 1. The District Vice-President shall recommend to the Sections Committee the Section to which the Subsection (or Division) shall be assigned.

h. The **Board of Directors** may at any time **terminate** the existence of any Section when in its judgment the interests of the Institute make such action desirable.

B80.031 Subsections. A Section may form one or more Subsections within its territory, as follows:

a. A Section may establish Subsections (or Divisions) in geographical areas within its assigned area. The Section is responsible for the operation of such Subsections (or Divisions) in accordance with regulations established by the Section.

b. A Petition to form a Subsection (or Division) is presented to the Section by the interested group, numbering not less than 15 members.

c. Approval. Establishment of the Subsection (or Division) must receive approval in turn from the Section, the District Representative of the Sections Committee, the District Vice-President, and the Chairman of the Sections Committee.

d. Notification. The Chairman of the Sections Committee shall notify Headquarters and all other interested persons of the final approval of the formation of the Subsection (or Division) and the date (first of the month) of organization as determined by the District Vice-President.

e. Termination. A Subsection (or Division) whose membership has become ten or less on August 1, or has held less than four meetings in a full fiscal year of operation, shall lose its status, and the allotment from Headquarters to the Section for the maintenance of such Subsection (or Division) shall be discontinued.

B80.032 The **Sections may hold meetings** at such times and places as may be determined by their officers, for the purpose of carrying on their work.

a. The **principal work of a Section** is the holding of regular meetings for the presentation and discussion of papers on matters relating to electricity, and to the allied arts and sciences. No action which may purport to represent the policy or organization of the Institute, or of any Section, shall be published or communicated to any party

or parties who are not members of the Institute, without the approval of the Institute, unless accompanied by a statement to the effect that as the AIEE is an international organization, the opinions or recommendations expressed represent only the views of the individual members of the . . . . Section.

b. A Section of the Institute may cooperate with other local engineering organizations in the holding of joint meetings, and may invite members of such organizations to its meetings.

B80.033 The **territory of a Section** is defined, wherever practical, by county line boundaries. Territorial assignments for the establishment of new Sections or reassignment of Section territories is subject to the concurrence of the Sections and District Vice-Presidents involved, and the Sections Committee.

B80.034 The **Chairman and Secretary** of each Section are elected for the term of one year, beginning on the date specified in the Bylaws of the Section. The Bylaws of the Section determine whether or not these officers are eligible for re-election.

B80.035 Section Meetings

a. Only **formal papers** are designated as papers in these Bylaws. Section officers should endeavor to include a number of formal papers in each year's program, so that, through publication in *Electrical Engineering*, a substantial number of high quality Section papers may be made available to the whole membership.

b. Section and Branch officers are responsible to the Institute for all Section and Branch papers and any recorded discussion of them.

c. Such papers are not released for publication in advance of presentation and, except as news items, the name of the Institute shall not be used in connection with their publication unless authorized by the Publications Department.

d. Section and Branch officers should make a reasonable effort to **obtain the manuscripts** of papers at the time of presentation, and these should be forwarded promptly to the Executive Secretary, with such recommendations as the Section and Branch officers wish to make with reference to publication.

e. Except as a news item, the name of the Institute shall not be used in connection with the publication, elsewhere than in *Electrical Engineering*, of subject matter presented as an informal talk before a Section or Branch meeting.

f. Where publication in *Transactions* of Section or Branch papers by nonmembers of the Institute is involved, approvals shall be obtained in accordance with B90.050.

B80.036 Section Finance

a. Each Section conducts its affairs in such a manner as to require for its maintenance only such **financial support** by the Institute as is consistent with the activities carried on by that Section. Except upon the request of a Section stating specific reasons therefor, and with the approval of the Sections and Finance Committees, the appropriation to any Section of Institute funds during any year shall not exceed in the aggregate a sum to be determined as follows:

1. Basic Allotment: Two-hundred dollars basic allotment; also an allotment of $100 to the Section for each of its Subsections holding regularly scheduled meetings.

2. Allotment per Member: One dollar and thirty cents each for Fellows and Members, and $1.00 each for other members within the Section's jurisdiction who have paid their Institute membership dues on or before October 31, excluding Members-for-Life and Honorary Members.

3. Additional Amount: An additional amount is allowed for a larger number of regularly scheduled Section, Subsection, and Technical Group meetings held during the preceding fiscal year (ending April 30), as follows:

12 to 17 meetings, $50
18 to 23 meetings, $100
24 to 29 meetings, $150
30 or more meetings, $200*

The Treasurer and Executive Secretary of the Institute shall forward in October of each year, to the Secretary of each Section, the amount to which each Section is entitled under this Bylaw.

*For a trial period the Board of Directors, on June 28, 1957, approved an extension of this payment schedule as follows:

30 to 35 meetings, $200
36 to 41 meetings, $250
42 to 47 meetings, $300
48 or more meetings, $350

and refund of the entrance and transfer fees to the Sections from which the applications originated.

B80.037 Section Delegates

Each Section is represented at the Conference of Section Delegates, by one official delegate.

a. The Section Delegates attending the Summer General Meeting shall be voting members of the Institute. The official delegate is the incoming Chairman, Chairman-Elect, or newly installed Chairman of the Section, or an alternate who is an elected officer of the Section for the coming year. The duties of these delegates are as follows:

1. To attend such meetings of the Sections Committee and Conference of Section Delegates as may be held during the Summer General Meeting.

2. To exchange views and experiences in connection with activities and management of Sections and to make recommendations of an advisory nature upon such matters to the Sections Committee.

3. To exchange and discuss ideas regarding subjects for inclusion in technical programs of future Section meetings.

4. To advise the Chairman of the Sections Committee at least 60 days in advance of the Summer General Meeting of questions of interest to the Institute Sections which, in their opinion, should be discussed by the delegates at the meetings of the Sections Committee during the General Meeting. The Chairman of the Sections Committee shall appoint a subcommittee, consisting of the Chairman of the Sections Committee and three other members of the Sections Committee, who shall prepare in advance of the Summer General Meeting a program of such questions for discussion.

b. Past Chairmen, incumbent Chairmen, or Chairmen-Elect of Sections, if in attendance at the

General Meetings, shall have the privilege of attending all meetings of the Sections Committee, but at the Conference of Section Delegates, only the official delegate is entitled to vote.

c. The expenditures for transportation of Section Delegates, and for all other committees or activities for which such appropriations are provided by the Board of Directors, shall be paid from the Institute Treasury at such rate per mile one way, from the place of residence to the meeting place, as may from time to time be determined by the Board of Directors.

B80.040 Overseas Chapters may be formed in any country outside the territorial limits specified in B80.030 for the formation of Sections, as prescribed in these Bylaws.

a. A **Petition** for the formation of an Overseas Chapter shall be signed, on a form provided by the Institute Headquarters, by not less than ten members residing within the territorial limits requested or thereinafter prescribed. The Board of Directors reserves the right to decline the petition if, in its judgment, the proposed Overseas Chapter is not compatible with the interests of the Institute.

b. The Overseas Chapter shall be known as the (name of place) Overseas Chapter of the American Institute of Electrical Engineers.

c. The Overseas Chapter shall be self-supporting financially and conduct its affairs without financial assistance from the Institute. The Institute shall not be held liable for any indebtedness incurred by an Overseas Chapter.

d. Travel allowance cannot be approved nor shall any be allotted to any officer, delegate, or member of the Overseas Chapter in attendance at meetings, or in the performance of any duties.

e. Observers from Overseas Chapters may attend the Section Delegates Conference at the Summer General Meeting of the Institute, but without voting privileges and without travel allowance.

f. All Overseas Chapters shall be assigned to District 3 for administrative purposes. Any visits by administrative officers of District 3 or of the Institute to the Overseas Chapters shall be without travel allowance unless granted by special action of the Board of Directors.

g. Overseas Chapters may be dissolved by action of the Board of Directors when, in its judgment, the Chapter is no longer serving the ideals and aims of the Institute.

B80.050 Student Branches may be formed at educational institutions where engineering or science curricula permit student membership.

a. **Request** for establishment of a Student Branch is by a voting member of the Institute who is also a member of the engineering or science faculty of the institution where the Student Branch is to be located.

b. **Establishment** of the Student Branch must receive approval of the District Vice-President whose jurisdiction is involved and the Chairman of the Student Branches Committee.

c. The Student Branch shall be organized under the designation (name of institution) Student Branch of the American Institute of Electrical Engineers.

d. A Student Branch may be terminated wherever the activity, or lack of activity, does not serve the interests of the Institute.

e. **Dual Student Branches** are permissible where the activities of day students are independent from those of the evening students. One is designated as the Day Student Branch and the other, the Evening Student Branch.

B80.051 Student Branch Organization. The Student Branch organizes by the election or appointment of an Executive Committee.

a. The **Executive Committee** consists of any suitable number of persons chosen from among the student members of the Institute.

b. Each Student Branch has a **Counselor** who is a voting member of the Institute and is selected from the engineering or science faculty of the institution involved.

c. The Branch **nominates an eligible Counselor** to the District Vice-President on or before March 1 of each year.

d. The **appointment of the Counselor** is made by the District Vice-President after consultation with the Student Branch officers or the school department head or both.

e. The **date limit for the appointment** of all Counselors is April 1. In the event any Student Branch has failed to submit a nomination by this date, the District Vice-President proceeds with his own selection and notifies the Student Branch and the appointee of the action taken.

f. Each year, the **District Vice-President notifies** Institute Headquarters of all Counselor appointments.

g. The **appointment** of Counselors is for one year and begins the following August 1.

h. Counselors are eligible for **reappointment** from year to year.

B80.052 The Office of Counselor. Counselors are responsible to the District Vice-President for the conduct of their respective Student Branches.

a. The Counselor acts jointly with the duly appointed Counselors of other national engineering societies in matters affecting the Student Branch and the welfare of its members.

B80.053 Student Branch Operation. Reports of the proceedings at each Student Branch meeting are made promptly by the Branch Secretary to the Student Branch Coordinator, with a copy to the Chairman of the Student Branches Committee and copies to other officers as may be instructed.

a. **Non-member students** of the institution where a Student Branch is established may attend the Student Branch meetings under such conditions as may be prescribed by the Student Branch.

B80.054 Joint Student Branches. A Student Branch established by the American Institute of Electrical Engineers may be jointly associated with Branches of approved national engineering societies having similar requirements and interests. A Student Branch operating jointly in this manner is called a Joint Student Branch.

a. The **initial organization** consists of at least 10 members, of which at least 25 percent are student members of the American Institute of Electrical Engineers.

b. The **Chairman** of a **Joint Student Branch** shall be a student member of the American Institute of Electrical Engineers.*

* 1. A student selected to serve as Chairman of a Joint Student Branch is required to belong to both societies, but is required to pay dues in only one. If he is a member of only one society at the time of election as Chairman, his application for membership in the other society without dues for one year will be endorsed by the Counselor of AIEE or the Representative of the approved national engineering society. If he is a member of both societies at the time of election, upon application to either society, endorsed by both the Counselor of AIEE and the Representative of the approved national engineering society, he will be given a refund of his student dues in that society for the current year.

c. **Societies approved** for the purpose of this cooperation in engineering education are: American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, American Institute of Chemical Engineers, Institute of Radio Engineers, together with other national engineering societies as may be approved from time to time as having similar requirements and interests.

d. **Admission privileges** are extended to those student members of the associated engineering societies enrolled in the Joint Student Branch as set forth in B30.010 and B40.011.

B80.060 The Standing Committees of the Institute are appointed by the President. In order to facilitate the administrative duties of the Board of Directors, the over-all operational functions of the Institute are divided into Departments to which certain standing committees and activities are delegated for combined supervision.

a. The authorized standing committees include those referred to in the Constitution, and their positions in the organization chain are as follows:

Responsible Directly to the Board of Directors
- Executive Committee
- Finance Committee
- Honors Advisory Committee
- Constitution and Bylaws Committee
- Planning and Coordination Committee
- Intersociety Relations Committee
- All Departments

Departments

General Administration Department
- Membership Committee
- Public Relations Committee
- Sections Committee
- Student Branches Committee
- Transfers Committee

Professional Development and Recognition Department
- Board of Examiners
- Edison Medal Committee
- Education Committee
- Fortescue Fellowship Committee
- Lamme Medal Committee
- Management Committee
- Members-for-Life Fund Committee
- Prize Awards Committee
- Professional Conduct Committee
- Recognition Awards Committee
- Registration of Engineers Committee
- Volta Scholarship Trustees

Publications Department
- Educational Publications Committee
- Periodicals and Transactions Committee
- Special Publications Committee

Technical Operations Department
- General Committees
- Technical Divisions
- New Technical Activities Committee
- Research Committee
- Safety Committee
- Standards Committee

b. General Information Regarding Standing Committees

1. In accordance with this organizational arrangement, each committee is **responsible to the next higher committee** or group in the organization chain. However, this organization procedure shall not prevent any committee or group from bringing any matter, which it considers to be in the best interests of the Institute, directly to the attention of the Board of Directors.

2. The **President designates** the **Chairman** of each committee or group and, with the advice and counsel of the Chairman, appoints the membership of each committee. The Chairman selects a Vice-Chairman and a Secretary of his committee. Additional members may be appointed to any committee by the President or the Board of Directors.

3. A **yearly report** of the activities is made by each committee or group and submitted to the Executive Secretary near the close of the fiscal year.

4. A **budget is prepared each year** by each committee, prior to March 15, of the income and expenses as may appear, in connection with its plans and programs for the ensuing year. Budgets are submitted in accordance with organization procedure, to the Finance Committee for collation and ultimate presentation to the Board of Directors for approval.

5. The **expenditures** of the Institute are **regulated** by annual appropriations and the expenditures of the committees shall not exceed their appropriations under any circumstances, without first obtaining proper approval. This applies to standing committees and special committees where their duties require expenditures.

c. Composition and Duties of Standing Committees Responsible Directly to the Board of Directors.

1. **Executive Committee**
See B70.020.

2. **Finance Committee.**

The Finance Committee consists of three members of the Board of Directors appointed by the President and, in addition to the duties prescribed in the Constitution, exercises appropriate control of the payment of all bills, through authorized personnel, and as authorized by the Board of Directors, directs the investment of moneys and all specific appropriations. It causes to be prepared for the information of the Board of Directors a budget of estimated receipts and expenditures for the ensuing year beginning May 1. It has the bank accounts and securities of the Institute examined prior to the annual financial statement made in the month of May, and certifies to their correctness. It employs a certified public accountant to audit the accounts at the close of each fiscal year. The Committee serves to give general supervision of the arrangements, furnishings, and maintenance of the Institute Headquarters and its historical relics, paintings, and works of art.

80.060 c (cont.)

3. Honors Advisory Committee.
The Honors Advisory Committee consists of six members of Fellow or Member grade, two appointed each year by the Board of Directors upon nomination by the President, for a term of 3 years beginning August 1 of the year of appointment. This Committee is charged with the continuing function of reviewing potential nominees for Honorary Membership, including suggestions that may be received from the Board of Examiners and others, and recommending to the Board of Directors candidates for election to Honorary Membership. This Committee is not to be listed in the published list of standing committees.

4. Constitution and Bylaws Committee.
The Constitution and Bylaws Committee consists of five members and considers all matters relating to the Constitution and Bylaws of the Institute, also all other matters referred to it by the Board of Directors, the President, or the Executive Secretary. The Committee makes reports and recommendations to the Board of Directors for action thereon and may consult legal and technical counsel with reference to any question before it. At least one member of the Committee shall be a member of the Board of Directors.

5. Planning and Coordination Committee.
The Planning and Coordination Committee includes in its membership the Department Chairmen, and members-at-large at the discretion of the President. Its Chairman shall be a member of the Board of Directors, and its Secretary is the Executive Secretary of the Institute. Its responsibilities include the following:

The Committee develops **broad, long range plans** and programs for the Institute, recommends methods for implementation of specific plans when adopted, and evaluates the progress and results of execution of these plans and their related functions.

It provides **coordination among Departments** as required, and initiates committees for special investigation wherever it seems investigation cannot be properly handled by existing organizations.

It **considers and advises** on all questions arising with reference to Institute activities of all types, particularly those in which uncertainty, difference of opinion, actual conflict, or duplication may appear to exist, whether referred to it by the Board of Directors or otherwise coming to its attention.

6. Intersociety Relations Committee.
The Intersociety Relations Committee consists of nine members appointed by the President. The terms of appointment of one-third of the members expire at the close of each administrative year. (Experience with the major federation and intersociety groups should, to the extent feasible, be represented in the membership of the committee.) The Chairman for each administrative year is designated by the President for that year. The Committee organizes as necessary to effectuate its assigned responsibilities.

The Committee reports to the Board and is responsible for the following:

Advising the Board on matters of policy with respect to current intersociety affairs.
Representing the Institute in negotiations of new intersociety relations.
Formulating methods for the application of Institute policy to intersociety problems.
Promoting the implementation of Institute policies and programs in the field of intersociety relations.
Carrying out any related activity assigned to the Committee by the Board of Directors.

d. Composition and Duties of Departments Responsible Directly to the Board of Directors.

1. General Administration Department.
The General Administration Department includes in its membership a Director as Chairman, the District Vice-Presidents, the Chairmen of the Membership Committee, Public Relations Committee, Sections Committee, Student Branches Committee, and Transfers Committee, and members-at-large at the discretion of the President. A Secretary is assigned from the Headquarters Staff, as recommended by the Executive Secretary.

The Department is responsible for the activities of the Membership Committee, Public Relations Committee, Student Branches Committee, Sections Committee and its Technical Group Organization Subcommittee, and Transfers Committee; and for Intersociety Representatives to:

AIEE-IRE Coordination Committee on Student Activities
American Association for the Advancement of Science, Council
Electrical Historical Foundation Board
Engineers Joint Council, Board of Directors
Library Board, United Engineering Trustees
United Engineering Trustees

It **supervises** the **activities** of its committees and groups, particularly in matters of coordination and execution of programs assigned to or developed by them; promotes continuous development of specific plans and programs which will enhance the activities of the Institute for the benefit and expansion of the membership; and supervises the execution of these plans and programs.

It **resolves all problems** which come to its attention that may be solved within the policies established by the Board of Directors, and recommends personnel to the President for appointment as AIEE representatives.

It **appoints** the **related Intersociety Representatives,** with the exception of Engineers Joint Council and United Engineering Trustees, which appointments will be made by the Board of Directors upon nomination by the President, after consultation with the Department.

2. Professional Development and Recognition Department.
The Professional Development and Recognition Department includes in its membership a Director as Chairman, the Chairmen of the Board of Examiners, Edison Medal Committee, Lamme Medal Committee, Fortescue Fellowship Committee, Professional Conduct Committee, Management Committee, Education Committee, Recognition Awards Committee, Prize Awards Committee, Members-for-Life Fund Committee, Registration of Engineers Committee, and Volta Scholarship Trustees, and members-at-large at the discretion of the President.

The Department **supervises the activities** of those assigned committees as represented in the Department's membership and the activities of the Intersociety Representatives assigned to it. It is

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responsible for continuing review of nominees for fellowships for post-graduate work and medals; and for carrying out the provisions of the Bylaws, Constitution, and Board Policy in the selection of recipients of fellowships and medals.

It **assists the Professional Conduct Committee** in the function of formulating or revising a Code of Professional Conduct as the need arises, and assumes responsibility for the administration of the Code.

It **reviews investigations** made by the Professional Conduct Committee in connection with practices of any members which were believed to have been prejudicial to the welfare of the Institute, the engineering profession, or of the community, and endorses that committee's findings to the Board, either approving the committee's recommendations or forming its own recommendation.

It has the **responsibility of approving regulations** and operating procedures for medal and award committees under its jurisdiction.

It is **responsible for the activities** of the following Intersociety Representatives:

Alfred Noble Prize Committee, ASCE
Charles F. Kettering Board of Award
Elmer A. Sperry Award Board
Engineers' Council for Professional Development
General Electric Educational Fund Fellowship Committee
Hoover Medal Board of Award
John Fritz Medal Board of Award
Marston Medal Board of Award
National Bureau of Engineering Registration, Advisory Board
National Council of State Boards of Engineering Examiners
Washington Award Commission

and **appoints the related Intersociety Representatives,** with the exception of the Engineers' Council for Professional Development, the Hoover Medal Board of Award, and the John Fritz Medal Board of Award, which appointments will be made by the Board of Directors upon nomination by the President, after consultation with the Department.

3. The Publications Department.
The Publications Department includes in its membership a Director as Chairman and at least eight members, appointed by the President, chosen to represent broadly the Institute activities in the fields of communication, electronics, general applications, industry, power, education, and technical publications.

The **Department includes:** The Chairmen of the Educational Publications Committee, the Periodicals and Transactions Committee, the Special Publications Committee, and members-at-large, at the discretion of the President.

This Department has **supervision of the monthly journal,** *Electrical Engineering*, the *Transactions*, and other publications of the Institute, including the form, size, arrangement, etc., of these publications; also decisions regarding the publication of papers, discussions, and all other matter available for publication, and the formulation and carrying out of plans for bringing into practice the policies regarding Institute publications that may be determined from time to time by the Board of Directors.

The Department **appoints and supervises** the activities of Intersociety Representatives as follows: AEC Advisory Committee on Industrial Information and Engineering Societies Monographs Committee.

4. Technical Operations Department.
The Technical Operations Department has a Director as Chairman, and a Secretariat assigned from the Headquarters Staff as recommended by the Executive Secretary. Included in the membership of the Department are two Vice-Chairmen, one past Chairman, members-at-large at the discretion of the President, and, ex-officio, the Technical Vice-Presidents, the Division chairmen, and the chairmen of standing committees assigned to the Department.

The **Department supervises the technical affairs** of the Institute and is responsible for the formulation of broad plans and programs designed to enhance the activities of the Divisions and technical committees; and supervises the execution of plans and programs which may be assigned to or formulated by the Divisions and technical committees. Also, it supervises the activities of the Intersociety Representatives assigned to it.

It **coordinates the activities of the Divisions and technical committees,** approves the formulation of technical committees or the discharge of committees no longer considered essential; and assigns to one Division the administrative jurisdiction of joint activities involving more than one Division.

It **coordinates the scopes of all technical committees,** coordinates joint activities with technical committees of other societies, and schedules General and District Meetings and Special Technical Conferences.

It **coordinates Special Technical Conferences** involving more than one Division, assigns to one Division the administrative jurisdiction of preparation of Standards and Recommended Practices involving more than one Division; and determines the requirements of the Divisions and technical committees as to technical papers for guidance of the Publications Department in preparing the budget.

It **cooperates with the General and District Meeting Committees;** arranges the programs for the technical sessions at General Meetings; formulates rules for the presentation and discussion of papers; and receives and handles reviews by the technical committees for all papers.

It **cooperates with Technical Discussion Groups** which are established in local Sections by providing technical guidance and encouragement.

The General Committees include the following:
Applied Automatic Techniques Committee
District TOD Representatives Committee
Man-Machine Integration Committee
Nuclear Congress and Nucleonics Committee

The Divisions include the following committees:

Communication Division
Broadcasting Committee
Communication Switching Systems Committee
Communication Theory Committee
Data Communication Committee
Radio Communication Systems Committee
Space Communication Committee
Telegraph Systems Committee
Wire Communication Systems Committee

General Applications Division
- Aero-Space Transportation Committee
- Domestic and Commercial Applications Committee
- Land Transportation Committee
- Marine Transportation Committee
- Production and Application of Light Committee

Industry Division
- Chemical Industry Committee
- Electric Heating Committee
- Electric Welding Committee
- Feedback Control Systems Committee
- General Industry Applications Committee
- Industrial Control Committee
- Industrial Power Rectifiers Committee
- Industrial and Commercial Power Systems Committee
- Machine Tool Industry Committee
- Metal Industry Committee
- Mining Industry Committee
- Petroleum Industry Committee
- Rubber and Plastics Industries Committee
- Textile Industry Committee

Instrumentation Division
- Aero-Space Instrumentation Committee
- Electronic and High-Frequency Instruments Committee
- Fundamental Electrical Standards Committee
- Indicating and Integrating Instruments Committee
- Nuclear Instrumentation Committee
- Recording and Controlling Instrumentation Committee
- Special Instruments and Auxiliary Apparatus Committee
- Telemetering Committee

Power Division
- Insulated Conductors Committee
- Power Generation Committee
- Power System Communications Committee
- Protective Devices Committee
- Relays Committee
- Rotating Machinery Committee
- Substations Committee
- Switchgear Committee
- System Engineering Committee
- Transformers Committee
- Transmission and Distribution Committee

Science and Electronics Division
- Basic Sciences Committee
- Computing Devices Committee
- Electrical Insulation Committee
- Electrical Techniques in Medicine and Biology Committee
- Electronics Committee
- Magnetic Amplifiers Committee
- Nucleonics Committee
- Semiconductor Rectifiers Committee
- Solid State Devices Committee

The Department is responsible for the appointment and supervision of AIEE representation on the following intersociety activities:

- American Automatic Control Council
- American Standards Association, Standards Council
- Engineering Foundation Board
- International Commission on Illumination, United States National Committee
- National Association of Corrosion Engineers, Intersociety Committee on Corrosion
- National Electronics Conference, Board of Directors
- National Research Council Advisory Panels for National Bureau of Standards
- National Research Council, Division of Engineering and Industrial Research
- Society of Plastics Engineers
- World Power Conference, United States National Committee

A Forum of Technical Committee Chairmen is held at least once each year. Its honorary presiding officer is the President. The Technical Operations Department is responsible for the scheduling and conduct of the Forum. Chairmen of general committees having technical interests are invited, particularly if their committees might be involved in any discussions. Any action taken by the Forum is purely advisory.

e. Composition and Duties of Committees of General Administration Department.

1. Membership Committee.
The Membership Committee consists of one representative from each District and a suitable number of other members, all appointed by the President.

This Committee brings the advantages of membership to the attention of desirable candidates for admission to the Institute, through such measures as it may consider advisable to interest prospective members who have the standing and qualifications specified for the various grades of membership. Under the general direction of the Chairman, the District Representative may enlist the cooperation of the Sections and Student Branches within his District in such work.

2. Public Relations Committee.
The Public Relations Committee consists of 6 or more members appointed by the President. The Committee prepares and disseminates information concerning the Institute and its activities, intended for distribution elsewhere than in the Institute's publications. It serves as an advisory body on all questions of Institute public relations. It cooperates with other Institute committees and with Section and Student Branch officers on the publicity phases of their particular activities.

3. Sections Committee.
The Sections Committee consists of a minimum of 20 members, appointed by the President, with each District represented by at least one member.

The Committee sponsors and is responsible for the promotion of Section activities and the formation of new Sections and recommends changes in Section territory assignments. The Committee confers with Section officers and it considers, investigates, and makes reports and recommendations for action on all matters regarding or involving the interest and welfare of the Sections or their relations with the Institute or other organizations. The Committee arranges for and holds an annual meeting of the Section Delegates during the Summer General Meeting.

4. Student Branches Committee.
The Student Branches Committee consists of not less than 20 members. The Committee shall include the Chairmen of the District Student Activities Committees, and other members-at-large ap-

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pointed by the President. The Committee has the general supervision and management of the Student Branches of the Institute. The Student Branches Committee is also concerned with the problems of individual student members having no Student Branch affiliation. The Committee confers with the Student Branch officers and it considers, investigates, and makes reports and recommendations upon all matters regarding or involving the interests and the welfare of Student Branches and students, or the relations between these organizations and the Institute.

5. Transfers Committee.
The Transfers Committee consists of a Chairman, a Vice-Chairman, a Secretary, members-at-large, and representatives from each District, all appointed by the President. This Committee encourages the Sections to establish and maintain in continuous operation their own local committees on transfers. The Committee prepares, with the approval of the Board of Examiners, a guide for use by the Sections' committees on transfers and other interested parties on the procedure to be followed for proposing transfers to Fellow grade. The Committee also prepares a guide for the functioning of the Sections' committees on transfers, for the purpose of encouraging and assisting eligible Affiliates and Associate Members in transfers to higher grades of membership.

f. Composition and Duties of Committees of Professional Development and Recognition Department.

1. The Board of Examiners.
The Board of Examiners consists of not less than 12 Fellows of the Institute. It considers the qualifications of applicants for election and transfer, where applications have been received by the Executive Secretary, which are in conformity with the appropriate sections of the Bylaws, and reports its findings to the Board of Directors for action.

2. Education Committee.
The Education Committee consists of not less than 20 members. Half of the committee shall be associated with engineering educational institutions and the other half shall be engaged in other activities. The Committee interests itself in all matters related directly or indirectly to education for the profession of engineering. It keeps alert to developing needs in this field. It develops policies with regard to content and standards of curricula, and cooperates with and assists ECPD through the Institute representatives on that body. It advises the Institute on matters having an educational aspect. By means of meetings, published papers, or reports, it is responsible for keeping the membership informed on trends in engineering education.

3. Registration of Engineers Committee.
The Registration of Engineers Committee consists of not less than 9 members appointed by the President. This Committee keeps informed on registration laws and amendments thereto, and cooperates with other societies and various examining boards. The Committee submits reports and recommendations regarding registration to its Department for such action as appears to be in the best interests of the engineering profession and the community.

4. Professional Conduct Committee.
The Professional Conduct Committee consists of 7 members. In addition to the function of formulating and administering a Code of Professional Conduct, it is the duty of the Committee to advise inquirers respecting questions of proper professional conduct, to examine and investigate any practice of any member of this Institute which may be regarded as prejudicial to the welfare of the Institute, the engineering profession, or of the community, and to report its actions and recommendations to its Department, which takes such action thereon as it may deem proper.

5. Management Committee.
The Management Committee consists of a minimum of 7 members. This Committee considers problems of management, insofar as they may be of importance to electrical engineers. Its scope includes methods of organizing men, money, materials, and research activities; personnel relations; and consideration of the relations between government, industry, education, and science. The Committee, from time to time, arranges general meeting programs or conferences and proposes articles of general interest or educational value for publication in *Electrical Engineering*. The Committee cooperates with similar committees of other organizations.

6. Members-for-Life-Fund Committee.
The Members-for-Life-Fund Committee consists of not less than 5 members. The Committee makes recommendations for the accumulation and disbursement of the Members-for-Life-Fund. The Fund represents continued payments of dues by Members-for-Life after the date at which they qualify for exemption from dues (in accordance with B40.013c), together with the returns from investment of unexpended fund principal.

7. Recognition Awards Committee.
The Recognition Awards Committee shall consist of not less than 24 members of Member or Fellow grade. Each new member is appointed for a term of 4 years. The President appoints 6 members each year. The Recognition Awards Committee has the responsibility of selecting the recipients of all awards and medals for outstanding achievement in the various fields of electrical engineering that are established by the Institute except the Lamme Medal and the Edison Medal.

8. Edison Medal Committee.
The Edison Medal Committee consists of 21 members, of whom 15 are appointed by the President from the membership at large, 3 to be appointed annually and to serve for a term of 5 years from August 1 of the year in which such appointments are made. Six are elected by the Board of Directors from its own membership, being 3 annually to serve from August 1 of the year in which they are elected, for a term of 2 years, excepting when a member so elected ceases to be a member of the Board of Directors prior to the expiration of the 2-year term, in which case his membership on the Edison Medal Committee shall terminate with his membership on the Board of Directors, and the Board shall elect a member of the Board of Directors to serve the unexpired term. The duties of this Committee are to make awards of the Edison Medal, in accordance with the regulations prescribed in the Bylaws of the Committee.

9. Lamme Medal Committee.
The Lamme Medal Committee consists of 9 members appointed by the President from the membership of the Institute, 3 to be appointed

each year and to serve a term of 3 years from August 1 of the year in which they are appointed. The duties of this Committee are to make awards of the Lamme Medal, in accordance with the regulations prescribed in the Bylaws of the Committee.

10. Charles LeGeyt Fortescue Fellowship Committee.
The Charles LeGeyt Fortescue Fellowship Committee consists of 6 members appointed by the President. The Committee awards each year to a student of electrical engineering, who has received a baccalaureate degree from a duly recognized technical school in the United States or Canada, a fellowship for post-graduate work in some special field of electrical engineering, in accordance with the regulations prescribed in the Bylaws of the Committee.

11. Volta Scholarship Committee.
The Alessandro Volta Scholarship Committee consists of 3 Members or Fellows of the Institute appointed by the President for 6-year terms. The terms are staggered so that one term expires every 2 years. The Committee awards, to a young Italian citizen, a graduate scholarship in electrical engineering at an acceptable engineering school in the United States, at such times and under conditions as the Committee lays down.

12. Prize Awards Committee.
The Prize Awards Committee includes in its membership one representative from each Division, and members-at-large at the discretion of the President. It considers and makes recommendations for the various forms of recognition among the membership, including the establishment of awards for the recognition of outstanding achievement, the establishment and award of prizes for superior papers, and the recognition of outstanding service to the Institute and to the profession. It also establishes rules and approves the award of prizes established by the Institute for outstanding papers, articles, or other forms of presentation of technical information.

g. Composition and Duties of Technical Divisions.
Each Division consists of a Technical Vice-President, a Chairman who may be the Technical Vice-President, a Vice-Chairman, a past Chairman, a Secretary who may be assigned from the Headquarters Staff, the chairmen of the technical committees assigned to the Division, delegate members from the standing committees as they are required, and at least two members-at-large.

The Divisions supervise the affairs of their respective committees. They serve as the coordinating agency for the activities of the technical committees within each Division; they recommend to the Technical Operations Department the formation of new technical committees within the field of activity of the Division, or the discharge of committees no longer considered essential; assign to one technical committee the administrative jurisdiction of subcommittees, working groups, or project committees jointly representing two or more technical committees within the Division; establish scopes for the technical committees within the Division, subject to coordination with other Divisions by the Technical Operations Department; recommend to the Technical Operations Department joint activities, with technical committees of other societies, not specifically assigned to any general committee; cooperate with the Technical Operations Department in formulating programs for General and District Meetings; coordinate Special Technical Conferences sponsored by technical committees within the Division; and initiate, independently or at the request of the Standards Committee, the preparation of Institute Standards and Recommended Practices by assignments to one or more of the technical committees within the Division. If the assignment involves other Divisions, the assignment is handled by the Technical Operations Department.

h. Composition and Duties of Committees of the Technical Operations Department.
The technical committees are each composed of a Chairman and members recommended by the retiring Chairman through the Division Committee. The incoming Chairman shall recommend the Vice-Chairman, Secretary, and additional members as he desires. The technical committees promote and coordinate Institute activity in their respective fields, and within their scopes have responsibilities as detailed below.

They pass on all technical papers; are responsible for the presentation of all papers at General Meetings, as arranged by the Technical Operations Department; arrange Special Technical Conferences, either alone or jointly with other committees; within their respective scopes, initiate and prepare Standards, recommend actions, and report on Standards activities to the Standards Committee. In general, they report through their respective Divisions. This organizational procedure does not prevent their bringing any matter which they consider in the best interests of the Institute directly to the attention of the Board of Directors. They prepare suitable yearly reports on their operation. They cooperate with similar committees of other societies. In case of doubt as to the scope, direction shall come from the Technical Operations Department.

Each technical committee, from time to time, as determined in cooperation with the Technical Operations Department, presents at a General Meeting of the Institute a report including a brief résumé of the progress of the art in the particular field within the scope of such committee, with the object that these reports may be authoritative sources of information on the history of electrical engineering development. These reports are, wherever practicable, published with discussion.

1. The Standards Committee consists of 15 or more appointed members. The Committee considers and investigates all matters relating to units and standards appertaining to or applicable in electrical engineering, and in the allied arts and sciences. The Committee coordinates the work of the technical committees with respect to the making and revising of AIEE Standards. It represents the Institute in cooperation with other standardizing bodies in matters relating to units and standards.

The Committee appoints AIEE representatives to serve on standardizing committees for which this Institute is sponsor, or on delegations for standardizing purposes which will serve under the sponsorship of other societies or organizations (ASA, ASME, IRE, etc.).

The Committee gives final approval to Standards in the name of the Institute unless one or more members of the Committee serves notice of dissent with intention of appealing to the Board of Directors. In such event, the Committee shall make immediate notification of the dissenting appeal, and submit a full report of the case. The Committee reports all new and revised Standards, and seeks the guidance and approval of its Department upon

ORGANIZATION (CONT.)

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all policy questions, including that of undertaking the preparation of Standards in new fields.

The Committee may delegate to a Joint Standards Committee sanctioned by its Department, authority for approval of Standards sponsored jointly with other organizations.

To facilitate the work of the Standards Committee, an Administrative Subcommittee shall be formed each year. By agreement between the Chairman of each Technical Division and the Chairman of the Standards Committee, a representative of each Division shall be recommended for appointment to the Division Committee, and to the Standards Committee with the understanding that they will be appointed members of the Administrative Subcommittee and will initiate and coordinate Standards activities within their Divisions. The organization, duties, and responsibilities of the Administrative Subcommittee are as determined by the Standards Committee.

2. Research Committee.

The Research Committee consists of 10 or more appointed members. The Committee stimulates research of interest to the Institute, acts on behalf of the Institute, may be specifically authorized to initiate and direct research investigations, cooperates on behalf of the Institute with departments of national and state governments in the consideration of research investigation, submits reports and recommendations concerning research investigations for which financial support from the Institute is sought; assists university staffs in selecting research projects for graduate students, and assists the Technical Operations Department in the preparation of meetings for the discussion of problems in the field of research.

3. Safety Committee.

The Safety Committee consists of 15 or more members; considers and investigates matters relating to the protection of persons and property against hazard due to or resultant upon the presence of electricity or the use of electric apparatus, material, and appliances, and reports to its Department such recommendations thereon as it deems desirable for action by the Institute. To this end, it encourages and coordinates safety consideration by other Institute committees in their respective fields, and with the approval obtained by organizational procedures, may arrange for cooperative relations with other bodies in the consideration of electrical hazards.

4. New Technical Activities Committee.

The New Technical Activities Committee consists of appointed members and liaison members; one liaison member with each Technical Division and with the Research Committee. The Committee shall promote and develop new technical activities, in conjunction with existing committees, until such areas of activity begin to crystallize into more readily recognizable scopes. It shall then recommend transfer of the activity to the existing committees, modified as necessary, or to new committees.

B80.061 Special Committees.

a. Each **Special Committee** appointed for any purpose involving expense to the Institute shall prepare an estimate of its probable expenditures and obtain approval thereof.

b. The Resolution establishing a special committee shall **define its functions.** At the beginning of each administrative year, the Executive Secretary shall transmit to all the members of each special committee whose duties may be continued, copies of the original Resolutions authorizing such special committees.

B80.062 Representatives of the Institute on Joint Committees.

The Board of Directors may, at its discretion, appoint representatives of the Institute upon joint committees, boards, and other local and national bodies, for the purpose of bringing about closer cooperation between the Institute and other organizations. The terms of these representatives terminate at the close of the administrative year, July 31, except where the terms are otherwise specified in the regulations of the body to which they are appointed.

B80.063 Representatives on John Fritz Medal Board of Award.

The representatives of the Institute on the John Fritz Medal Board of Award shall be the 3 surviving Past-Presidents most recently retired. Each year the junior surviving Past-President, on October 1, shall become a representative of the Institute on the John Fritz Medal Board of Award, and the functions of the senior surviving Past-President of the Institute on this Board shall then terminate. In the event of the inability of any of the three most recently retired Past-Presidents to serve as a representative, his successor shall be the next most recent surviving Past-President of the Institute, and such successor shall hold office for the term of the representative in whose place he is appointed.

MEETINGS AND PUBLICATIONS

B90.010 Annual Meetings.

The Annual Meeting of the Institute is held during the Summer General Meeting, the date and place to be determined each year by resolution of the Board of Directors, approved by not less than a majority of the total membership of the Board.

B90.020 Meetings.

a. There shall be four General Meetings of the Institute each year; namely, the Winter General Meeting, the Summer General Meeting, the Pacific General Meeting, and the Fall General Meeting. Additional meetings may be recommended from time to time by the Technical Operations Department. The Board of Directors determines the location of all General Meetings and may postpone or omit any such meetings.

b. The President shall appoint a General Meeting Committee for each meeting. The duties of this Committee shall consist of making all necessary local arrangements for the meeting, in cooperation with the Executive Secretary and the Technical Operations Department. The program for the technical sessions is under the jurisdiction of the Technical Operations Department. The number of technical sessions and the assignment of definite periods of time for these sessions should be decided after conference with the Technical Operations Department, so that the other events may be conveniently arranged in order to provide a well-balanced program. The Chairman of the General Meeting Committee will appoint such subcommittees as he deems necessary, as for example, Publicity, Finance, Technical Program, Inspection Trips, Entertainment Features, Hotel Arrangements, etc.

c. District Meetings shall be held, upon the approval of the Technical Operations Department in each instance, under the supervision of the District officers and committees, in accordance with the following general plan:

Upon expression by a District Executive Committee of a desire to hold a District Meeting, and approval by the Technical Operations Department, the responsibility for the meeting shall rest with a District Meeting Committee, appointed by the District Vice-President, and composed of members within the District, preferably located in the area where the meeting is to be held. This Committee shall have full responsibility and authority for organizing and conducting such a meeting in all its detail, including the arrangement of sessions, the entertainment features, and, subject to B80.060d4, the selection of papers. Papers for a District Meeting may be obtained from the District membership by the District Meeting Committee and, if papers are desired from outside the District, they may be obtained by cooperation with the Technical Operations Department. All papers included in the program shall be considered for publication upon the same basis as papers for General Meetings. The financing of District Meetings shall be in accordance with a consistent general plan approved from time to time by the Board of Directors, after consideration of such recommendations as may be received from the officers and committees concerned.

B90.050 Publications.

a. The regular publications of the Institute shall include *Electrical Engineering* to be published monthly; *Communication and Electronics, Applications and Industry, Power Apparatus and Systems,* each to be published every 2 months; and the *Transactions* to be published quarterly, semi-annually, or annually.

b. *Electrical Engineering* may have two principal divisions:

1. For current matter and Institute news;
2. For general articles pertaining to the profession, technical papers, and other matters of an engineering character.

c. The *Transactions* shall contain the papers and discussions which have appeared in the Bimonthly publications and such other engineering matter as may be approved for publication in *Transactions* by the Publications Department.

d. The manuscript of any paper to be presented at a General Meeting of the Institute must be received at Institute Headquarters for the consideration of the Technical Operations Department not less than 90 days before the date of presentation.

With a view to setting up a schedule for the orderly conduct of the work, the Technical Operations Department may specify such additional periods as may be necessary. The Executive Committee shall have the power to waive the 90-day requirement upon request of the Chairman of the Technical Operations Department.

No paper shall be announced for presentation at any General Meeting until after the paper has been accepted for presentation by the Technical Operations Department.

e. Authors and co-authors of general and technical articles which are published in *Electrical Engineering* or Bimonthly publications will each be given two complimentary copies of the issue containing their contributions. Additional copies will be furnished at the special authors' price of 25 cents per copy, postpaid, provided the order is placed in advance and five or more copies are shipped to one address at one time.

Reprints of any paper published by the Institute will be furnished at nominal cost provided orders are placed in advance of publication, and for quantities of 100 or more. The Editorial Department will quote prices upon application.

f. All committees responsible for the preparation of technical programs are to direct their activities so that all authors of technical papers will be members of the Institute, insofar as this is consistent with keeping the membership fully informed as to developments in the electrical arts and sciences and in closely allied fields. It is recognized that there may, from time to time, be situations in which non-member authors or co-authors are desirable in order to obtain an authoritative presentation of the subject matter, particularly in fields foreign, but closely allied to, the electrical arts and sciences. In such cases, papers by non-members are accepted under regulations approved by the Board of Directors.

g. The President may invite any non-member to discuss any paper presented at a meeting of the Institute, and the Chairman of any Section may invite any non-member to discuss any paper presented at the Section of which he is Chairman.

h. A paper or discussion may be revised editorially under the direction of the Technical Operations Department or the Publications Department, but shall be returned to the author for his consent to publication as revised. In the event of disagreement, the author and the Technical Operations Department or Publications Department shall work out a mutually satisfactory arrangement before publication by the Institute.

i. Only original papers are acceptable for presentation and publication. On notification of acceptance, all papers become the property of the Institute. The publications of the Institute are copyrighted but permission to republish is usually granted, provided proper credit is given to the authors and the Institute.

j. No paper or address approved by the Technical Operations Department for presentation at a General or District Meeting, or any written contribution to a discussion thereon, shall be released for publication in advance of presentation except by authority of the Technical Division whose committee is responsible for the paper. In the latter case, a statement shall accompany publication specifying date for submission of discussions and the paper shall be presented later, in an abbreviated form, if desired by the Division.

k. No person shall receive monetary compensation from the reprinting of any paper or discussion presented before the Institute or before any Section or Student Branch without previous authorization from the Board of Directors.

B90.060 Membership List.

A membership list shall be published and made available to the members of the Institute at such intervals and on such bases as determined by the Board of Directors.

AMENDMENTS AND RESOLUTIONS

B100.010 Effective Date. New or amended Bylaws become effective on the first day of August following their adoption, unless otherwise specified by the Board of Directors. In the latter case, a prominent announcement shall be made in *Electrical Engineering*.

B100.020 Numbering. The Executive Secretary may number and, from time to time, when amendments are adopted, may renumber the various sections of the Bylaws so as to serve the purpose of ready reference thereto.

B100.100 Resolutions. The Resolution establishing a temporary committee shall define its functions. At the beginning of each administrative year, the Executive Secretary shall transmit to all members of each temporary committee whose duties may be continued, copies of the original Resolutions constituting such temporary committees.

(Continued from p. 849)

ing his telephone career, Dr. Schelkunoff made fundamental contributions in the field of electromagnetic theory, in theoretical studies of waveguides for transmitting microwaves, and in research on antennas for radio communication. He served as a consultant on wave propagation to the National Defense Research Committee and the U. S. Navy during World War II. Dr. Schelkunoff was awarded the Morris Liebmann Memorial Prize in 1942 by the Institute of Radio Engineers "for contributions to theory of radio wave transmission." In 1949, the Franklin Institute awarded him its Stuart Ballantine Medal "for outstanding research in communication and reconnaissance." Dr. Schelkunoff was associated with Ball Laboratories—and its predecessor organization, the engineering department of the Western Electric Company—since 1923, except for the period during 1926-29 when he was a member of the faculty of the State College of Washington. He was associated with the Laboratories' mathematics department during 1929-58, and was appointed assistant director of mathematic research in 1956. In 1958, he became assistant vice-president in charge of university relations.

C. W. Schemm (AM '27, M '47), principal electrical engineer of Sverdrup & Parcel Engineering Company, St. Louis, Mo., has been installed as president of the Missouri Society of Professional Engineers. He is a past chairman of the St. Louis Section, AIEE.

S. S. Schneider (M' 50) has been appointed vice-president in charge of operations of the Emerson Research Laboratories, a division of Emerttron, Inc. This is a subsidiary of Emerson Radio and Phonograph Corporation, Silver Springs, Md.

R. C. Short (AM '50, M '58), formerly Ontario District sales manager for Ferranti-Packard Electric Ltd., has been appointed marketing manager of Edwards of Canada Ltd. at Owen Sound, Ont., Canada.

R. E. Shrader, Jr. (AM '51), formerly with the Chrysler Missile Division of Chrysler Corporation, Detroit, Mich., has been appointed a sales engineer in Ampex Data Products Company's Instrumentation Division, Redwood City, Calif. Mr. Shrader has been assigned to the company's Midwest District with Michigan and Northern Ohio as his territory.

A. E. Sprando (AM '55) has been appointed to the position of chief engineer of Iron Fireman Manufacturing Company's Electronics Division, Portland, Oreg. Mr. Sprando has been head of product development for the division.

H. R. Stevenson (AM '46), manager of sales, Detroit Edison Company, Detroit, Mich., has been elected assistant vice-president. He will continue his duties as manager of sales. **L. W. Clark** (AM '25, F '49), assistant manager of operations, has been advanced to the position of manager of operations. **R. M. Van Duzer, Jr.** (M '50), general superintendent of production, succeeded Mr. Clark as assistant manager of operations. Mr. Clark has served the AIEE as a past chairman of the Michigan Section, District secretary (1956-58), and on the Electric Welding Committee (1938-45, chairman 1944-45).

H. F. Taylor, Jr. (AM '56) has been named manager of product planning for the Rectifier Components Product Section of the semiconductor products department of the General Electric Company in Auburn, N. Y.

R. D. Teasdale (AM '46, M '54) has been appointed to the newly created post of project manager of an advanced electronic air defense system at Hughes Aircraft Company, Culver City, Calif.

W. M. Terry, Jr. (AM '48, M '55) has been named general manager, electrical departments, of Allis-Chalmers Manufacturing Company's Industrial Equipment Division. Mr. Terry, who was director of engineering co-ordination for the Allis-Chalmers Industries Group since 1957, is now responsible for the operations of the Norwood (Ohio) Works, including the electrical and pump departments there, and the control and industrial systems departments, and the rectifier section at the West Allis Works.

James Van Ness (AM '52, M '57) has been promoted to full professor of electrical engineering at Northwestern University. Dr. Van Ness had been associate professor. He has served on the AIEE System Engineering Committee (1954-60).

A. E. Vivell (AM '36, M '40) was appointed by the Secretary to the Navy to the position of academic dean at the U. S. Naval Postgraduate School to succeed **R. S. Glasgow** (AM '20, F '48, Member for Life) upon his retirement as dean on July 1, 1960. Dr. Vivell has been a member of the Naval Postgraduate School faculty since 1945, as associate professor for 1 year, and as full professor of electrical engineering since 1946. Dean Glasgow, who served the U. S. Naval Postgraduate School since 1949, continues his services to the school in the capacity of dean emeritus. Dr. Vivell has served on the AIEE Student Branches Committee (1958-60).

U. S. Navy

A. E. Vivell

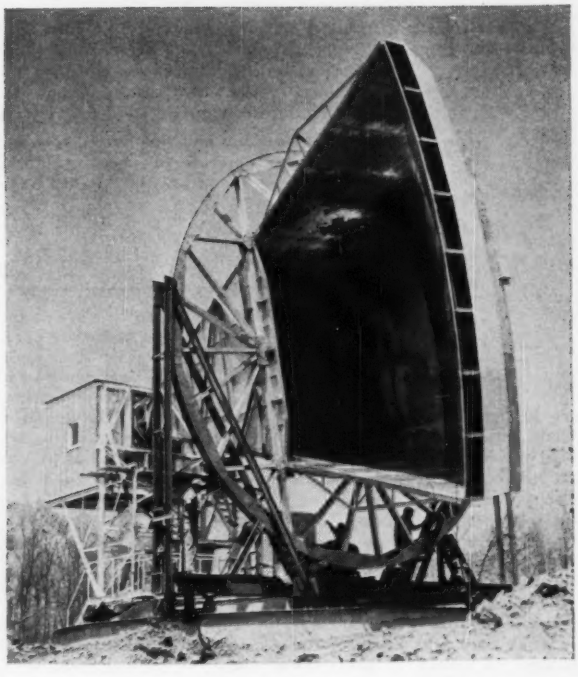
J. W. Wallace (AM '41, M '48) has been appointed manager of the Westinghouse Electric Corporation's Manufacturing and Repair Division. He was formerly assistant manager of the M & R division at company headquarters in Pittsburgh.

K. T. Wilder (AM '52) has joined the Information Technology Division of Lockheed Electronics Company as senior scientist in the Division's computer systems group. Mr. Wilder joined Lockheed from the Kearfott Company of Clifton, N. J.

E. M. Wolf (AM '41, M '46), has been named technical director of Rea Magnet Wire Company, Inc., division of Aluminum Company of America. Most recently, he was assistant chief engineer of the Aluminum Company's Rome Cable division.

R. L. Zahour (AM '53, M '55), manager of lamp applications for the Westinghouse Electric Corporation's Lamp Division, has been elected regional vice-president of the Northeastern region of the Illuminating Engineering Society. His 2-year term of office will begin October 1. The region covers six sections and one chapter in an area which extends from Albany, N. Y., to Trenton, N. J. Mr. Zahour has served on the AIEE Production and Application of Light Committee (1955-60).

OF CURRENT INTEREST



THE "EAR" of the most sensitive voice radio receiver yet built is this horn-shaped antenna at the space communication research facility of Bell Telephone Laboratories in Holmdel, N.J. The cab at the small end of the horn houses the radio receiving circuitry and a ruby maser amplifier refrigerated to —456 F. The antenna, 50 feet long, is rotated by the upright wheel. It also rotates about the base so that it will be able to track fast-moving satellites anywhere in the sky.

Scientists Talk Coast-to-Coast By Bouncing Voices Off the Moon

SCIENTISTS carried on a coast-to-coast telephone conversation recently by "bouncing" their voices off the moon.

The signals were beamed by Bell Telephone Laboratories scientists from their installation in Holmdel, N.J., via the moon, to the Jet Propulsion Laboratory in Goldstone, Calif.

The experiment was the first public demonstration of a 2-way "moonbounce" conversation; however, Bell Laboratories and Jet Propulsion Laboratory had accomplished the feat before.

The transmission was another step in the aligning and testing of radio transmitters and receivers for use in satellite communication experiments, such as Project Echo, to be conducted in cooperation with the National Aeronautics and Space Administration (NASA).

The voice of W. C. Jakes of Bell Laboratories, engineer in charge of the demonstration, was beamed from a 60-foot dish-shaped antenna to the moon, some 240,000 miles away. Although the signal traveled at the speed of light, it took about 2.5 seconds to complete the trip of nearly ½ million miles to Goldstone.

The voices from Goldstone, loud and clear as they came over the speaker at Holmdel, also required about 2.5 seconds to cover the distance, making it nearly 6 seconds from the time a question was asked or a statement was made at Holmdel, until a reply was received from California. Bell Laboratories transmitted at a frequency of 960 mc at 10 kw, while Jet Propulsion Laboratory transmitted at 2,390 mc.

The experimental space communication station at Holmdel was completed earlier this year at a cost of some $600,000 to the Bell System. It consists of a 10-kw transmitter, a 60-foot diameter transmitting antenna, a unique horn-shaped receiving antenna, and associated tracking equipment. At the Jet Propulsion Laboratory in Goldstone, an installation operated for NASA, there are two 85-foot-diameter antennas for transmitting and receiving.

In the Holmdel radio receiver, three elements combine to produce an extremely high sensitivity. One is the movable, horn-reflector antenna, 50 feet long. Another is a special demodulation circuit especially valuable for space communication. The third element is a highly sensitive ruby maser amplifier, cooled by liquid helium to —456 F, which is re-used.

A smaller version of the horn-reflector antenna was developed several years ago by Bell Laboratories for overland radio relay. One of its outstanding features is that it picks up less radio "noise" from the earth than conventional antenna forms would. The 50-foot length used in the satellite communication system is the largest horn antenna yet constructed.

The transmitting and receiving antennas were aimed continually at the moon. This was done by a computer programmed with the moon's positions in relation to the Holmdel antennas. The computer's electric output was fed to the driving mechanisms of the antennas and moved them every 2 minutes in azimuth and altitude.

In addition to the automatic computer control of the antennas' positions, there is an optical tracking unit by means of which the antennas can be aimed manually.

Through a 20- by 20-foot opening, the

◄ IN the control room of the Bell Laboratories space communication station at Holmdel, N.J., are L. R. Lowry (*foreground*), and W. C. Jakes, project engineer, talking on the telephone. From here, telephone messages have been beamed to the moon and reflected to the Jet Propulsion Laboratory, Goldstone, Calif.

horn receives weak signals from space and directs them into the small end of the horn. Attached to the small end is a cab in which the maser amplifier is located.

At the heart of the maser is a 6-inch rod-like industrial ruby. The element that gives a ruby its distinctive hue—chromium—also accounts for its amplifying property, for in maser operation the chromium atoms are stimulated to emit radiation.

In the assembled masor, the ruby is contained in a waveguide cavity, and closely coupled to a comb-like traveling-wave structure which gives broadband width and stability necessary for satellite communication. These parts are surrounded by a magnetic field and cooled almost to the temperature of absolute zero. The maser generates 100 times less noise than comparable electron tube amplifiers.

In the receiver circuitry a special "frequency modulation feedback circuit" is used. It improves the signal-to-noise ratio a hundredfold, giving a high-quality audio output for a weak radio signal.

First Contact

In 1946, scientists achieved the first contact with the moon when a radar echo was received at Ft. Monmouth, N.J. The Naval Research Laboratory achieved the first reflected voice signal in 1954.

Last year, scientists from the Massachusetts Institute of Technology (MIT) successfully transmitted a voice signal one-way, via the moon, to the Jodrell Bank station in Great Britain. The other part of the conversation, from Great Britain to the United States, came via the Bell System's transatlantic telephone cable.

During the past several months, Bell Laboratories has also engaged in a number of successful 1-way moonbounce experiments with Jet Propulsion Laboratory, Jodrell Bank, and others.

In addition, the Laboratories has reflected voice signals off two 100-foot diameter aluminized spheres launched from Wallops Island, Va., in January and February by NASA. The signals, reflected while the sphere was at an altitude of some 250 miles, were received by the MIT at Round Hill, Mass. **EE**

BELL TELEPHONE LABORATORIES "telephone terminal to outer space" at Crawford Hill, Holmdel, N.J. A telephone conversation was "bounced" from here recently, via the moon, to Jet Propulsion Laboratory in Goldstone, Calif. Near the foreground is the 50-foot-long horn-reflector receiving antenna developed by Bell Laboratories for space communication experiments. The transmitter, a 60-foot parabolic dish, is shown in the rear.

Calculation of Fallout Gamma Radiation

A method for calculating fallout gamma radiation intensities within structures has been developed by C. Eisenhauer and L. V. Spencer of the National Bureau of Standards working under the sponsorship of the Office of Civil and Defense Mobilization. The method makes possible simple calculations of intensities within basements, and it can be used to find, at the center of a structure, the intensity of radiation entering through windows. With further refinement, it should provide an improved theoretical approach to the analysis of shielding properties of structures.

In general, for a simple structure, fallout radiation particles will be distributed uniformly over the roof of the structure and on the ground surrounding it. The radiation that reaches a detector inside can then be separated into that part coming through the walls and that coming through the roof. The intensity, or dose rate, of gamma radiation within the structure will depend mainly upon barrier attenuation (a function of barrier thickness and density) and geometrical attenuation (a function of the solid angle subtended at the detector by the barrier).

The geometrical attenuation from sources on the roof can be described in terms of a single geometry factor. The dose rate from roof sources is then equal to the product of the barrier factor (barrier attenuation) and the geometry factor.

The geometrical attenuation of radiation from sources on the ground is somewhat more complicated because the direct radiation behaves differently from the radiation that has been scattered in the walls. The direct radiation reaches the detector only from below, while scattered radiation may reach it from either above or below. In the present method, the geometry factor for radiation from the walls is therefore separated into a direct and a scattered component. The geometry factor for direct radiation has long been understood. Although the exact value of the geometry factor for the scattered radiation has not yet been calculated, it is known to lie within certain limits and to vary slightly with wall thickness. A suitable value may therefore be estimated. It is also known that the radiation emerging from very thin walls is almost entirely direct radiation, while that emerging from very thick walls consists almost entirely of scattered radiation. For very thin walls, then, the dose rate is obtained as the barrier factor times the geometry factor for the direct radiation; while for very thick walls, the dose rate equals the barrier factor times the geometry factor for scattered radiation. For walls of intermediate thickness, the dose rate is obtained as the sum of the two products, each weighted according to the relative amounts of scattered and direct radiation.

Although several experiments have been performed to measure dose rates inside structures surrounded by artificially radioactive sources, the results of these experiments do not provide a proper test of calculations made by the Bureau's method because of complicating factors such as the presence of floors and inner partitions in the building. However, data suitable for comparison were obtained from a controlled experiment made at the Army Chemical Warfare Laboratories using cobalt-60 sources distributed around a concrete blockhouse. The blockhouse is 12 feet long, 12 feet wide, and 8 feet high. Data were taken at ground level, 3 feet above ground, and 6 feet above ground at the center of the structure for wall thicknesses of 4 and 8 inches of concrete. Although the data are somewhat limited, they verify the trends predicted by the calculations. **EE**

Support the New United Engineering Center

Dish-Shaped Radio Beacons Send Tracking Signals from Echo

TWO space-borne radio beacons, each about the size and shape of an ordinary dinner plate and equipped with a half-ounce radio transmitter no larger than a cigarette lighter, are sending back the signals that enable ground stations to track the Echo balloon satellite as it circles the earth. The radio beacons were specially developed by the Radio Corporation of America (RCA) for the National Aeronautics and Space Administration (NASA).

The project, the first in a long-range space communications program initiated by NASA, calls for bouncing signals off the 100-foot plastic sphere between the Jet Propulsion Laboratory in Goldstone, Calif. and Bell Telephone Laboratories facility at Holmdel, N.J.

Barton Kreuzer, division vice-president and general manager of the Astro-Electronics Division, RCA Defense Electronic Products, Princeton, N.J., announced that the two beacons are the only operating electronic devices carried on the satellite, which was launched from Cape Canaveral by NASA. Installed on opposite sides of the 100-foot balloon, the transmitters broadcast a steady tone as Echo moves in orbit. Their signals provide a constant radio "fix" for the directional ground antennas that are being used experimentally to communicate from point to point by reflecting messages from the balloon's aluminized surface.

The heart of each beacon, and the source of the signals, is the half-ounce transistorized transmitter, one of the most compact yet developed for use in space. The transmitter and a miniature storage battery are embedded in molded foam plastic to form the complete assembly—an 11-ounce disc 10 inches across and only $\frac{3}{8}$ inch thick, designed to fit snugly against the huge balloon. On its upper surface, each disc carries an array of 70 solar cells to produce power from sunlight, and a circular groove holding a slender antenna.

The device was developed by J. G. McCubbin and H. B. Goldberg, engineers at the Space Center of the RCA Astro-Electronics Division at Princeton. The engineers explained that the disc-shaped units were designed to be attached to the skin of the collapsed balloon before its insertion in the launching container. When the balloon was ejected from the container and automatically inflated to its full 100-foot diameter, the antenna on each of the units sprang erect from the groove on the surface of the disc and each of the transmitters was automatically switched on.

The engineers pointed out that the combination of solar cells and rechargeable storage batteries in the beacons provide power in both sunlight and shadow as Echo circles the earth in its orbit. They explained that the solar cell array on either of the two units produces enough energy to power both transmitters and to recharge the batteries.

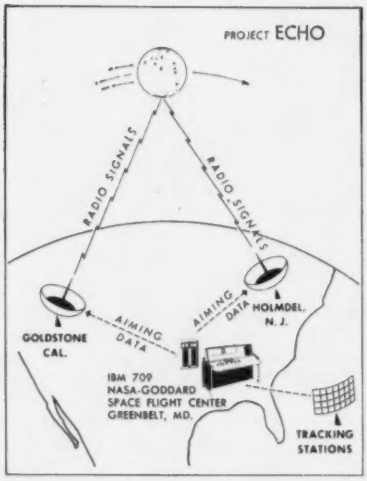
The two beacons are linked together by thin printed wiring that circles the inflated balloon, so that both transmitters receive power from a solar cell array when only one of them faces the sun. The transmitters radiate over 5 milliwatts of power at frequencies of 107.94 and 107.97 mc.

Computer Aims Antennas at Echo Satellite

An electronic computer at NASA's Goddard Space Flight Center, Greenbelt, Md., is catching the Echo communications satellite on the fly each time it circles the earth.

The computer—an IBM *709*—aims radio equipment from the east and west coasts on the gas-filled sphere during its speedy 16-minute crossings of the United States. Accurate aiming depends upon how precisely the computer can predict the satellite's position in the sky.

Like a duck hunter leading its quarry in flight, the IBM *709* computer predicts that precise point in time and space when

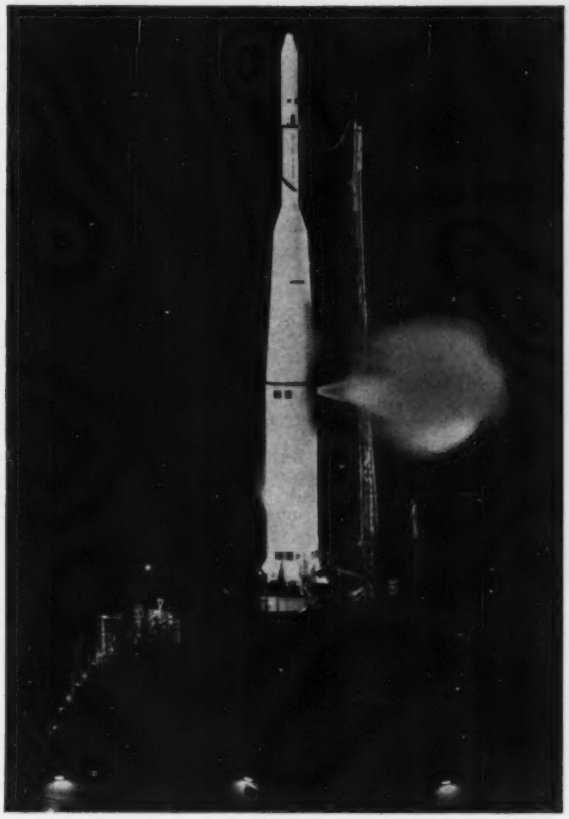


AN ULTRA-FAST IBM computer at the NASA-Goddard Space Flight Center in Greenbelt, Md., aims radio antennas on both coasts at the Echo satellite and tells scientists when to bounce signals from the huge 100-foot-gas-filled sphere. Drawing is an artist's concept showing how the computer feeds aiming data to the two antennas. The big dishes flash messages to one another via the Echo satellite in a transcontinental experiment which may lead to global communications systems for television, radio, telephone, and telegraph.

NASA photo

NASA photo

PREPARATION (*left*) of a Project Echo aluminum-coated plastic satellite. A technician (*background*), checks plastic cap which will be placed over the opening (*foreground*), sealing the ends of 82 flat gores fitted and cemented together to form the satellite. On the work table, the satellite—held in place by 12-inch clothes pins and partly obscured by a white vinyl covering—is slightly more than 157 feet long. Right: Echo payload. At top is the 26-inch-diameter magnesium container in which the sphere is folded. From the circular telemetry rack, four pole antennas are folded down over the third stage during launch. At injection into orbit, they are released, spring up and lock.



DELTA launch vehicle, which boosted the Echo communications satellite into orbit at 5:30 a.m. EDT, August 12, 1960, from Cape Canaveral, is shown on its launch pad. The plume from the Delta fumes results from liquid oxygen vented prior to launch.

NASA photo

the communications stations must lock on Echo if they are to bounce their radio signals successfully from one to the other.

The satellite presents a fast-moving target. It travels from west to east at approximately 16,000 mph in an orbit nearly 1,000 miles high.

Within minutes after launching of the 3-stage rocket that carried Echo into orbit from Cape Canaveral, the computer in the Goddard Space Flight Center prepared a preliminary orbital timetable on the basis of "sightings" from the Atlantic Missile Range. These were relayed to California and New Jersey while the satellite sped round the far side of the earth. Other orbital predictions were to be prepared in NASA's Center and transmitted throughout the world for use by experimenters interested in having a trial bounce of their own off the aluminum-coated sphere. **EE**

Projection in Broad Daylight Possible

Military pilots will be able to watch radar screens in bright daylight right in the cockpit, as a result of a new Kodak surfacing material for projection screens. In special applications the new surface gives a brightness gain of several hundred times over the usual beaded screens.

The new material is a film base embossed with 1 million lenses, mirrors, or prisms per square inch, coated with a highly reflective aluminized layer. Possible applications include projection of television images or data displays for air weapons systems, according to A. F. Fultz, superintendent of optical instrument design at Kodak's Apparatus and Optical Division in Rochester, N.Y.

Pictures with excellent highlight brightness have been obtained in aircraft flight simulators on an experimental basis with a small cathode ray tube projector.

In actual flight, cathode ray tube displays that now require darkness for viewing might be projected on a screen in full daylight view of the pilot. Because of the selectiveness of the system, which depends for brightness on the position of the observer, images from separate projectors can be shown on the same screen. The images are viewed individually by the pilot and co-pilot from different angles.

The type of optical element used in the surfacing material can be chosen to broaden or narrow the audience space. The narrower the audience space—the space limited by the positions where the screen image can be seen—the brighter the image.

Several images may be projected on the screen simultaneously and each viewer will see from his position only those intended for him.

There will be no conflict or disturbance of the images, it was stated.

Light from outside sources is concentrated by the screen in audience spaces away from the observer's position. **EE**

Future Meetings of Other Societies

15th Midwest Quality Control Conference, Oct. 14-15, Broadview Hotel, Wichita, Kans. H. K. Mitchell, 602 South Brookside, Wichita 18, Kans.

5th International Congress on High-Speed Photography, Oct. 16-22, Sheraton Park Hotel, Washington, D. C. Society of Motion Picture and Television Engineers, 55 W. 42nd St., New York 36, N.Y.

48th Annual National Safety Congress, Oct. 17-21, Conrad Hilton Hotel, Chicago, Ill. R. L. Forney, National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

42nd National Metal Congress and Exposition, Oct. 17-21, Convention Halls and Bellevue-Stratford Hotel, Philadelphia, Pa. G. M. Basford Co., 60 E. 42nd St., New York 17, N.Y.

Society for Experimental Stress Analysis, Annual Meeting, Oct. 19-21, Claremont Hotel, Berkeley, Calif. R. F. Steidel, Jr., Society for Experimental Stress Analysis, University of California, Berkeley 4, Calif.

NEMA, Annual Meeting, Oct. 23-27, Las Vegas, Nev. National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y.

Institute of Radio Engineers

7th East Coast Conference on Aeronautical and Navigational Electronics, Oct. 24-26, Lord Baltimore Hotel, Baltimore, Md.

1960 Electron Devices Meeting, Oct. 27-28, Shoreham Hotel, Washington, D. C. IRE, 1 E. 79th St., New York 21, N.Y.

ASA, 11th National Conference on Standards, Oct. 25-27, Sheraton-Atlantic Hotel, New York, N.Y. American Standards Association, 10 E. 40th St., New York 16, N.Y.

ASID, 16th Annual Conference, Oct. 27-28, Edgewater Beach Hotel, Chicago, Ill. The American Society of Industrial Designers, 15 E. 48th St., New York 17, N.Y.

Computer Applications Symposium, sponsored by Armour Research Foundation of Illinois Institute of Technology, Oct. 26-27, Morrison Hotel, Chicago, Ill. A. Ungar, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

Aircraft Electrical Society, 1960 Industry Display, Oct. 27-29, Pan Pacific Auditorium, Los Angeles, Calif.

MAECON, Mid-America Electronics Conference, Nov. 15-16, Hotel Muehlebach, Kansas City, Mo. L. R. Crissman, Trans World Airlines, 10 Richards Rd., Kansas City, Mo.

BRI, Fall Conferences, Nov. 15-17, Shoreham Hotel, Washington, D.C. Building Research Institute, Div. of Engineering and Industrial Research, National Academy of Sciences, 2101 Constitution Ave., Washington 25, D. C.

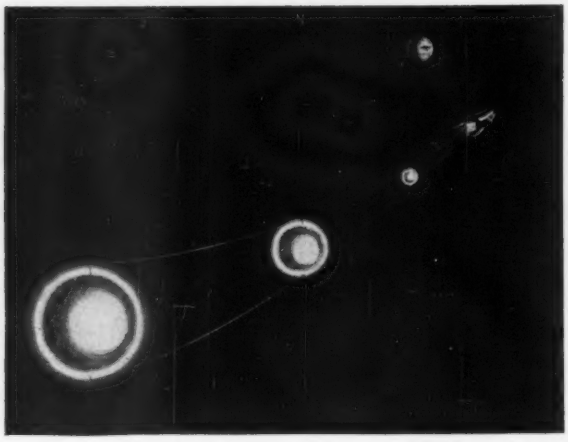
24th National Exposition of Power and Mechanical Engineering, Nov. 28-Dec. 2, New York Coliseum. Same, 480 Lexington Ave., New York 17, N.Y.

Overseas

INTERKAMA, International Congress and Exhibition for Instrumentation and Automation, Oct. 19-26, Dusseldorf, West Germany. Nordwestdeutsche Ausstellungs-Gesellschaft MBH, Ehrenhof 4, Dusseldorf, West Germany.

Symposium on Experimental and Test Reactors, Nov. 28-Dec. 2, Vienna, Austria. International Atomic Energy Agency, 11 Kartner Ring, Vienna 1, Austria.

Industrial Latin American Partnership Exhibition, Apr. 1960-Oct. 1961, Parque Ibirapuera, Sao Paulo, Brazil. E. L. Neville, ILAPE Representative, 60 E. 42 St., New York 17, N. Y.



THIS drawing of spherical nuclear reactors speeding through space behind the space ship represents Lockheed Missiles and Space Division's proposal for a nuclear powered–ionic propulsion system for deep space exploration.

Nuclear Space Ship for Two-Year Trip to Jupiter

A deep-space vehicle operating under full thrust for the 2 years necessary to carry it to the planet Jupiter with enough residual power to operate its instruments for several years thereafter, was revealed recently by a Lockheed Missiles and Space Division scientist.

Speaking before the Institute of Astronautical Sciences in Stockholm, Sweden, Dr. R. H. Olds described a nuclear-thermionic-ionic propulsion system to provide a continuous power supply by direct conversion of heat to electricity. The entire system, designed without any moving parts, will operate unattended in space with little likelihood of failure. "The key to the whole system," said Dr. Olds, "is a series of small nuclear reactors about 2 feet in diameter producing 1,200 C temperatures to banks of thermionic generators which convert the heat directly into electric energy for the ion beam motors."

The use of cesium vapor as fuel for the motors is proposed. "With such a system, 110 pounds of propellant would be capable of delivering an equal weight of payload to Jupiter," said Dr. Olds. "Small as the reactors are, they will still only use about one tenth of one percent of their energy potential; thus, the vehicle will have several years of reserve power after arrival at the planet."

It was pointed out that equipment reliability has been one of the major stumbling blocks in space vehicle development. Conventional equipment such as generators, motors, pumps, and similar items containing moving parts cannot be depended upon for unfailing operation over long periods in the space environment.

In this connection, it was noted that even with the fantastic speeds necessary for space travel, the time in transit from the earth to other planets in our solar system ranges from months to years, and to go beyond the solar system to the nearest stars requires travel time several orders of magnitude greater. **EE**

Nuclear Power Plant Achieves Criticality

The nuclear reactor for the nation's latest atomic power plant went critical at Rowe, Mass., on August 19. Yankee Atomic Electric Company's plant located there, is the first nuclear-powered electric generating station in New England and will begin producing power later this year for the 10 utilities which jointly own the facility.

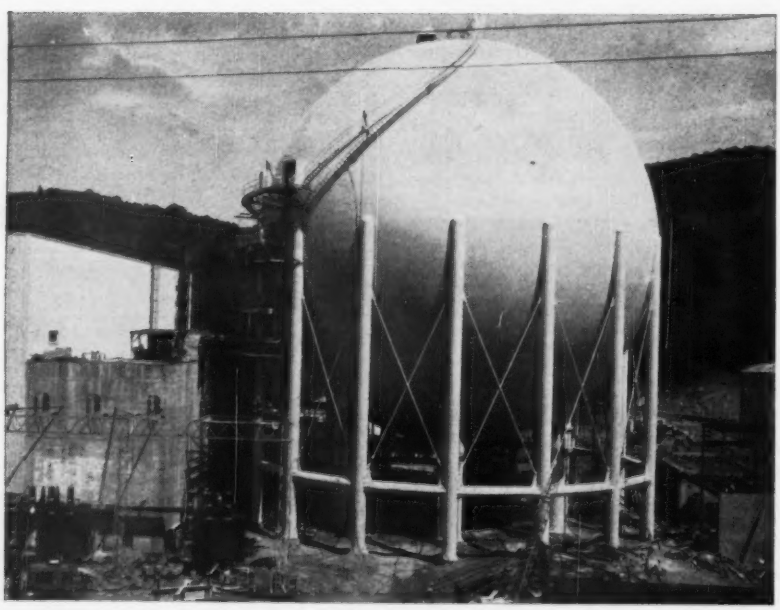
C. H. Weaver, vice-president–atomic power products for Westinghouse Electric Corporation, explained that the Yankee reactor is the latest advance in the development of water cooled and moderated nuclear reactors. Criticality represents an important milestone in the 3-year construction program of the 134-megawatt atomic electric generating station, he said. The reactor is the largest yet designed and developed by Westinghouse.

Yankee engineers put the plant into its criticality phase following 2 weeks work while 76 uranium oxide fuel assemblies were individually placed in position. Before the fueling operation was started, a 20-ton barrel-like structure was lowered into the pressure vessel to support the 76 fuel assemblies which make up the core, or fuel charge, of the reactor.

The core support is a stainless steel cylinder about 6 feet in diameter and 18 feet high which supplies the structural support for the fuel assemblies inside the reactor. The engine support was lowered into the 165-ton pressure vessel with only $\frac{1}{16}$-inch clearance from the sides of the vessel. In addition, the core support will help guide 24 control rods which adjust the rate of the fission process in the reactor. Fissioning atoms in the reactor will heat high-pressure water in the primary system to 529 F.

Water in the primary system is under a pressure of 2,000 psi and will flow through the pressure vessel at a rate of 94,800 gallons per minute. This water will be pumped through a heat exchanger, causing water in a separate secondary water system to turn into steam. From this point on, the generating station operation is exactly the same as at a conventional station. The steam drives a turbine-generator to produce electric power.

Westinghouse and Stone & Webster Engineering Corporation have been jointly



SHOWN in the final stages of construction is the 125-foot-diameter steel sphere to house the nuclear reactor for Yankee Atomic Electric Company's 134,000-kw power plant. Westinghouse Electric Corporation's atomic power department in Pittsburgh, Pa., designed and built the reactor portion of the plant. This giant sphere, known as the vapor container, is set on steel columns. A railroad track was built under the container so that a shipping car could be moved into position directly under a hatchway through which equipment, including the reactor and its pressure vessel, could be loaded.

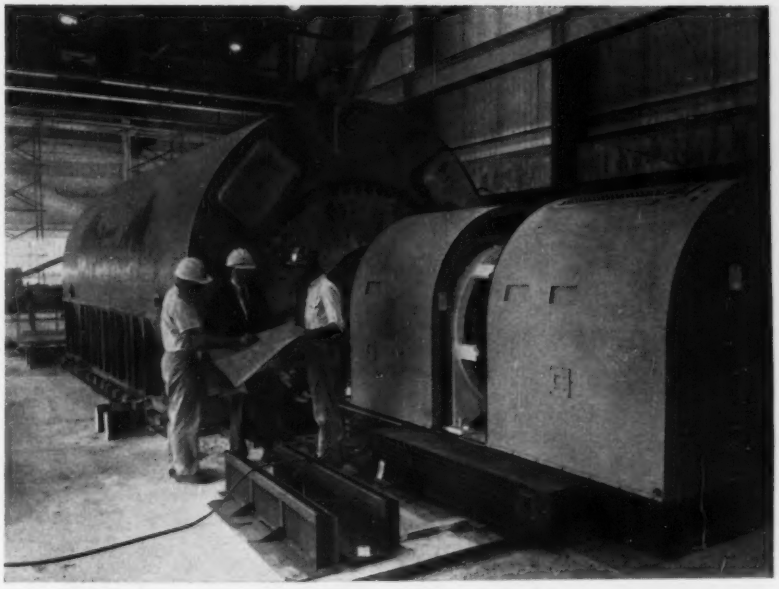
responsible for the engineering design of the plant. Westinghouse developed the nuclear steam generator and is also supplying the turbine-generator and other electric apparatus. Stone & Webster handled the over-all design, layout, and construction of the plant.

Electricity from the Yankee atomic installation will be fed into the electrical transmission grid of the sponsoring companies that provide five-sixths of the electricity used in New England. Utilities participating in the Yankee project which will receive power from the nuclear generating station include New England Electric System, The Connecticut Light and Power Company, Boston Edison Company, Central Maine Power Company, The Hartford Electric Light Company, Western Massachusetts Electric Company, Public Service Company of New Hampshire, Eastern Utilities Associates, New England Gas & Electric Association, and Central Vermont Public Service Corporation.

The Yankee reactor fuel consists of 25 tons of slightly enriched uranium oxide pellets. More than 23,000 stainless steel tubes filled with these pellets have been fabricated into the 76 fuel assemblies, each of which is approximately 8 feet long and 8 inches square. The uranium oxide pellets are 0.294 inch in diameter and 0.6 inch long. There are almost 3.5 million of them in the reactor.

The 24 control rods, made of a silver-indium-cadmium alloy, have been arranged throughout the reactor core to absorb a portion of the neutrons and thus control the rate of the fission process.

EE



ELECTRIC POWER from New England's first nuclear power plant will come from this generator installed at the Rowe, Mass., site of the Yankee Atomic Electric Company plant. Built by Westinghouse Electric Corporation, the generator is designed to be hydrogen-cooled and to have a useful net power output of 134,000 kw. When the plant starts full operation late in 1960, it will feed electric power to the 10 utilities in New England that combined to finance, build, and operate the Yankee Atomic plant.

Luminous Ceiling Material Meets Lighting Requirements

A new type of rigid vinyl luminous ceiling material combines exceptionally high light-transmission qualities with even diffusion. It has been selected to meet the critical lighting requirements of the gauge control room of General Electric's ordnance department plant in Pittsfield, Mass.

"Circlgrid" panels were designed and developed by Cirvac Plastics of Erie, Pa. In the General Electric installation, very stringent lighting specifications had to be met because of the large number of optical-type gauges and instruments in the room. The panels provide a transmission efficiency of 68% compared to the 48% of standard vinyl diffusers. Illumination here is at the 150 foot-candle level with a brightness ratio never exceeding 5 to 1. Circlgrid is made in varying translucencies; because of this fact, increased brightness control can be accomplished in very high foot-candle installations.

Circlgrid panels are made by vacuum-forming 0.015-inch translucent vinyl sheets to provide closely spaced circular depressions ¼-inch deep and ½-inch wide. Two of these sheets, with the circular depressions fitted back to back, are then electronically bonded in sandwich-fashion with a 0.008-inch vinyl membrane, making an assembly ½-inch thick. They are furnished in the standard 23¾- by 23¾- and 23¾- by 47¾-inch panels.

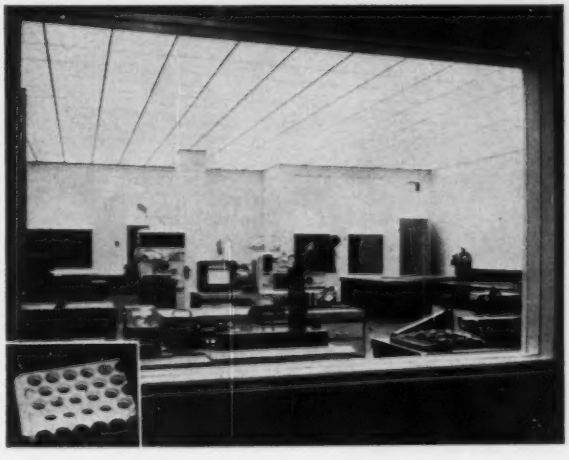
The Circlgrid panel may be left unpunctured, but for most applications, including the General Electric installation, a ⅜-inch hole is punched at the center of each circular area. The holes are designed to give intrinsic light control—brightness is reduced in the glare zone between 45 and 90 degrees. As a result, higher foot-candle installations are allowed and this can be used to meet the Illuminating Engineering Society's illumination standards.

The special construction of the panels gives some additional advantages. The holes reduce dust and insect collection. They enable easy cleaning by rinsing the panels back and forth in a detergent solution. Also, air is free to circulate through the plenum.

Most important, the holes allow sprinklers to be mounted behind the panels, yet operate effectively. The National Board of Fire Underwriters has approved the use of vinyl diffusers in this regard with perforations of ¼ inch or over in diameter.

Circlgrid panels do not support combustion, and are listed by Underwriters' Laboratories as "non-combustible" with a flame spread rating of 20. The panels have been approved by the building code of practically every major city, including the very strict New York code.

The panels are available from several



"CIRCLGRID" panels here give proper lighting for optical-type gauges and instruments. This gauge control room is at General Electric Company's ordnance department plant at Pittsfield, Mass. The lighting panels are made from a special Bakelite rigid vinyl sheeting providing even diffusion, crack resistance, and easy fabrication by sealing. Inset shows close-up detail and cross-section of Circlgrid material.

leading lighting manufacturers, many of whom list combination lighting and suspension systems. Patents have been applied for in the United States and foreign countries. Circlgrid panels are fabricated from Bakelite rigid vinyl sheeting supplied by Union Carbide Plastics Company, Division of Union Carbide Corporation. This material provides controlled, even light diffusion, high resistance to cracking, long life, and easy fabrication by sealing. EE

High-Resolution Scanning Antenna

An antenna developed by the National Bureau of Standards (NBS) promises to provide science with a new tool for experimental studies of the ionosphere. Without benefit of electrical or mechanical moving parts, it scans a 42-degree azimuthal arc and can determine immediately the direction of radio signals received from a "forward-scatter" transmission.

In this type of very-high-frequency (vhf) radio propagation, radio energy is scattered from cloud-like concentrations of electrons in the lower ionosphere and may arrive at the receiver site from any number of directions. The new development can pinpoint instantly the direction from which the scattered signal arrives and could prove invaluable in tracing "best paths" for forward-scatter communication. It can be adapted for use in the observation of a number of other ionospheric phenomena.

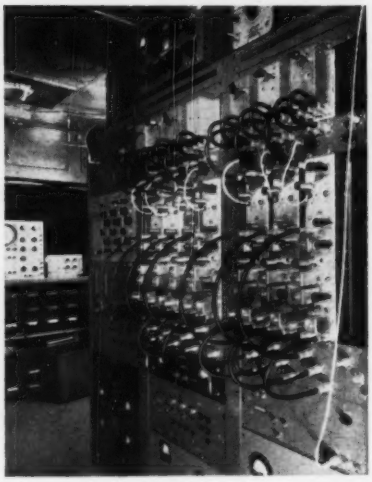
At Table Mesa, a field station of the NBS Boulder Laboratories, H. V. Cottony and A. C. Wilson, of the Antenna Research Section's Radio Systems Division, have erected a row of seven 5-element Yagi antennas, directed along the Great Circle Path to the NBS Long Branch field station transmitter in Havana, Ill.—800 miles distant from Boulder. The number of elements in the array is now being increased to 25 to permit a beam width of only 1.5 degrees.

Radio signals beamed from the Havana station at a frequency of 41 mc into the ionosphere are received at Table Mesa, but, heretofore, the direction from which the signal was reflected by the electron "clouds" has remained unknown.

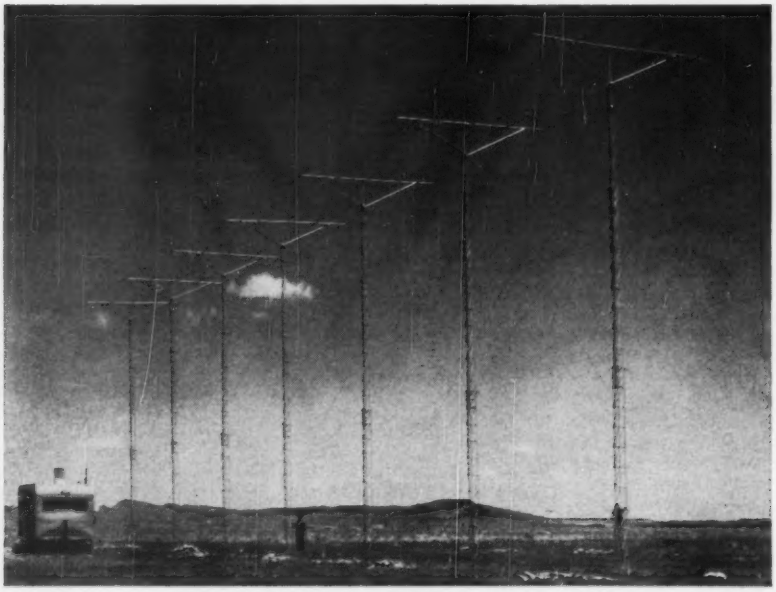
The electronic rapid scanning device, developed for use with the moderately directive Yagi antennas, swings a 5.8-degree beam in azimuth through the 42-degree sector 20 times a second. An oscilloscope synchronized to the incoming signal permits direct viewing or photographing. The device is novel in that it operates by purely electronic control of phasing and involves no mechanical apparatus such as that used for the sweep of radar antennas.

The ionospheric forward-scatter mode of radio propagation has distinct advantages in that it is resistant to the polar blackouts which so often cause complete fading in other modes of short-wave propagation. Up to the present, there has been no method for determining the path of the received signal, but now the direction of arrival of an ionospheric scatter signal can be seen—and followed as the signal path shifts.

Besides providing a method for study of long-distance ionospheric forward-scatter communication phenomena, the antenna will be a valuable tool for other experimental studies. Bearings of ionized meteor trails may be obtained instantly. The principle is applicable to a design of an antenna array for riometers (devices that listen to extra-terrestrial, or cosmic, noise which partially penetrates the ionosphere). It could be used as a small-space, multidirection antenna for receiving and—with design changes—for transmitting. It is considered to have a number of possible uses in many of the research programs now probing toward outer space. EE



THE electronic rapid scanning device, contained in a trailer on Table Mesa beside the Yagi antennas with which it is used, swings a 5.8-degree beam in azimuth through the 42-degree sector 20 times a second. An oscilloscope (background) is synchronized to the incoming signal and permits direct viewing and photographing. The device is unique in that it operates by purely electronic control of phasing and involves no mechanical apparatus such as that used for the sweep of radar antennas.



A ROW of seven 5-element Yagi antennas, used in conjunction with an electronic scanning device, has been erected at Table Mesa, a field site near Boulder, Colo., by the Antenna Research Section of the National Bureau of Standards Boulder Laboratories. This new development can pinpoint instantly the direction of radio signals received from a "forward-scatter" transmission. It can also be adapted for use in the observation of a number of other ionospheric phenomena.

Satellites Inflated with Plastic Foam Proposed

Tomorrow's space stations and special-purpose statellites may be built with balloon-like tubes that can be folded into compact packages for launching and inflated automatically in space with a plastic foam hardened by the sun's heat, an engineer of the Radio Corporation of America (RCA) said recently.

This technique is now under study at RCA's Astro-Electronics Division, Princeton, N. J., as a possible solution to the problem of setting up in space very large structures, such as extensive solar energy collectors and radar antennas 60 feet or more in diameter. It was described by C. C. Osgood, manager, design engineering, of the RCA division.

Mr. Osgood said the use of inflatable tubes promises to overcome the size and weight limitations encountered in launching folded structures designed to be set up in space. As an example, he pointed out that an inflatable tube structure weighing only 32 pounds could provide a disc 44 feet in diameter capable of carrying a solar cell array weighing 420 pounds.

"For smaller short-life applications, a gas bottle large enough to inflate and maintain the leakage rate of the array is considered satisfactory," said Mr. Osgood. "But for the larger, longer-life devices, the maintenance of shape and rigidity by continuous gas pressure is inadmissible because of the weight of tankage. An arrangement of rigid ribs and hinge-lock combinations appears feasible, but is eliminated because of the high weight of the many pieces of hardware and frequent difficulty in meeting the folding requirements.

"Additional search for methods of inflation leads to the use of 'foam-in-place' structural members. This process makes use of the increase in volume—from three to fifty times between liquid reactants and the solid foam product. Before curing, the foam has some fluid properties, and its pressure, plus that of the escaping by-products, can be used as the inflation pressure. The cured foam could provide the permanent rigidity required to retain the shape of the array. This would obviate the need for continuous gas pressure or for transporting rigid structural members."

Mr. Osgood said that engineers at RCA's Princeton Space Center are now investigating methods of foam inflation and the development of plastic foam materials sufficiently resistant to the radiation encountered in space. He discussed several possible methods of foam inflation based on combination of the reacting elements by their simultaneous injection into the inflatable structure when the satellite is released in orbit from the launching vehicle.

A further method under study, according to Mr. Osgood, is the use of "frozen" materials that would be combined in the collapsed satellite structure before launch and kept below the reaction point by refrigeration techniques until the orbit is achieved. In orbit, solar heat would start the reaction, generating the foam to expand the structure, and curing the foam to the desired hardness. **EE**

Portable Infrared Viewer

A portable infrared viewer, weighing only 2½ pounds complete with batteries, is now being marketed by the Industrial Products Division of International Telephone and Telegraph Corporation, San Fernando, Calif.

Developed for use in police work, medical research, and the observation of film processing, the viewer also has an unusual application in detecting forgeries in oil paintings or other works of art.

Completely self-contained, including optics, image converter tube, 6-kv transistorized power supply and mercury cells, the viewer has the added feature of an adapter to replace the eyepiece so that images may be fed directly to a television or film camera. The 9½- by 4- by 3½-inch viewer operates from either a 117-volt a-c or a standard 12-volt d-c source.

The viewer uses an image converter tube which has a response of 0.4 to 1.2 microns, a resolution of 25 line pairs per mm, and a minimum infrared conversion index of 2. The gun-like unit is normally supplied with a 3-inch Soligar 16-mm F: 1.9 lens, but is also available with any 16-mm standard C-mount lens. **EE**

MINIATURE infrared viewer developed by Industrial Products Division of ITT.

Light Beam Tunnel Used for Atlas Azimuth Alignment

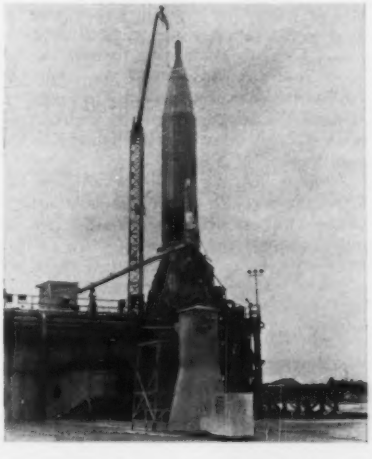
An unusual light beam tunnel connects the theodolite shelter with the instrumentation pod of the all-inertial guidance system to be installed in later models of the U.S. Air Force Atlas.

The double-walled tunnel, a 16-inch-diameter 35-foot-long tube, encloses the light beams which are transmitted from the azimuth alignment theodolite system to a prism connected to the stable platform. The tunnel gives the alignment system an all-weather capability. Overcast can distort the light beam, thus causing alignment difficulties prior to flight firing.

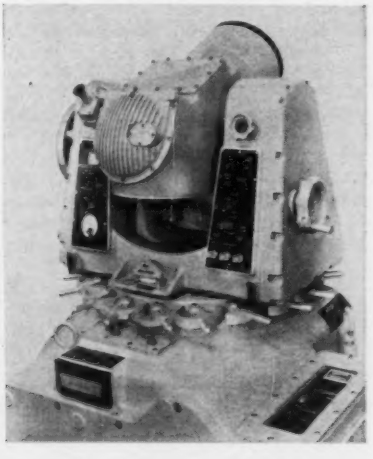
Accurate azimuth alignment is crucial since it gives the missile a correct azimuth heading. Error of several seconds of arc can result in off-target impact of many miles on a 6,000-mile-range firing.

The theodolite electro-optical system establishes a fixed geographical reference in the inertial guidance system's gyroscopes by precise measurement of angles from well-defined "bench marks" in the launching area. Azimuth orientation of the missile is performed automatically to the moment of launch by a closed electronic loop between the theodolite and the stable platform in the Atlas instrumentation pod. This pod is located above one of the missile's boosters.

The theodolite system, approximately 8 by 8 by 6 feet, is housed in a steel-walled shelter which is air-conditioned for stability and operating environment. A shutter mechanism on the housing end of the light beam tunnel closes to protect the instrument from exhaust and flame dur-



AN ATLAS launching pad at the Air Force Missile Test Center, Cape Canaveral, shows azimuth alignment equipment installation. The equipment, housed in steel shelter at left, is connected to the instrumentation pod of the all-inertial Atlas by means of a light beam tunnel. A section of the tunnel falls, retracts, and a shutter closes on the front of the shelter, prior to first motion of the missile. Pylon-shaped housing in the foreground encloses the reference bench mark used by the Perkin Elmer electro-collimator to establish the correct azimuth alignment for the Atlas.



ELECTRO-COLLIMATOR developed by Perkin-Elmer under contract to Arma is used in azimuth alignment of the Atlas inertial guidance system. The main housing, supported in the trunnion, is the auto collimator member of the electronic collimator assembly and contains all the optical systems and a portion of the equipment electronics. The trunnion houses four replaceable electronics: the electronic chassis and instrument panel on the left side; the power chassis and power panel on the right side. Access to each chassis is provided by a cover assembly.

ing static and flight firings. A section of the missile end of the tunnel retracts prior to first motion of the Atlas.

Twin light beams emanating from the theodolite and traveling up the tunnel are reflected back to the instrument by the mirror prism on the stable platform. Any alignment error causes the beams to pass through a slit in the monitor's main prism and activates a photomultiplier tube. This creates an error signal representative of the direction and extent of misalignment. Transmission of the error signal via the closed-loop system automatically drives the guidance platform back into proper alignment.

Azimuth bench mark reference is located in another steel-walled air-conditioned shelter situated alongside the Atlas firing stand, approximately 60 to 70 feet (line of sight) from the theodolite shelter. Azimuth reference bench mark consists essentially of a Poro prism mounted atop a 18-inch-OD 14-inch-ID pipe, which is driven 70 feet into the ground for stability purposes.

Perkin-Elmer, Norwalk, Conn., manufactures the theodolite electro-optical systems under a $1.5 million contract with Arma Division of American Arma Corporation, responsible for the Atlas all-inertial guidance system. EE

Nuclear Design For U.S. Air Force

Some details of design studies for a nuclear-powered aircraft that could fly nonrefueled to the limit of the crew's endurance were revealed recently by the U.S. Air Force and Convair Division of General Dynamics Corporation.

Drawings were released showing two swept-wing planes, each having an assembly of jet-like engines mounted in the tail of the fuselage. This style is one of several possible configurations under study at Convair's plant in Fort Worth, Texas, where nuclear plane research is conducted for the Air Force.

The canard-type planes lack conventional tails. At each wing tip is a vertical stabilizer-rudder assembly. The horizontal stabilizer-elevator surfaces are placed far forward on the fuselage, like stubby wings.

One design is for the direct-air-cycle nuclear engine, a type under development by the General Electric Company. The drawing for this aircraft shows a pair of conventional jet engines mounted under the wings, in addition to the nuclear powerplant.

The other design employs indirect-cycle engines, a type under development by Pratt & Whitney Aircraft.

Which type of nuclear power plant will be used in the first plane has not been determined.

Convair has been conducting nuclear aircraft studies for the past 9 years.

A converted B-36 bomber with reactor aboard was test flown for 2 years to study radiation effects on aircraft components, and to determine the best methods of protecting crewmen from the effects of radiation. EE

Electronic Fishing Line

Fish everywhere are taking a dim view of a new "electronic fishing line" developed by U. S. Steel's American Steel and Wire Division, which holds promise of bigger catches for commercial fishermen.

The new line, produced at the Wire Division's Electrical Cable Works, at Worcester, Mass., actually is a steel cable carrying electrical conductors which could make it possible for commercial fishermen to use a wide range of electrical and electronic devices to indicate the exact depth of their nets, when the nets are on the bottom, the ground speed of their trawl, and the size of their catch.

The cable, designed to make commercial fishing more scientific, is being tested by the U. S. Bureau of Commercial Fisheries' exploratory fishing vessel, *John N. Cobb*, off the Pacific coast.

Specifically, the new cable, or "warp" as it is known in trawling jargon, can be used with a number of devices to improve yield. A depth telemeter attached to the warp indicates how deep the trawl is fishing, thus permitting crews to lower or raise the nets with pin-point accuracy to snare a catch located beforehand by echo sounding.

Another instrument which can feed information through the new cable is an on-bottom indicator. This signal device is triggered by a spring-loaded switch on the bottom of the trawl door. When the door is closed, because of the pressure of the sea bottom against it, a light burns in the pilot house. If trawling speed is too fast or underwater currents are encountered which affect the functioning of the trawl gear, causing it to rise from the bottom, the trawl door opens. This throws the spring-loaded switch on the door and the light in the pilot house goes out.

Once a concentration of fish has been plotted by echo sounding, it is important to keep the trawl on course and moving at a closely regulated speed. A ground indicator, similar to a speedometer, helps the crew determine progress of the trawl along the sea bottom without reference to wind, current, or propeller speed. Impulses from this contact device, transmitted along the cable from sea depths to the crew above, also aid in maneuvering the trawl close to on-bottom contours.

Another advantage in using the cable is that thermometers installed on the warp indicate the temperatures of waters where the nets are fishing. Since fish concentrations may be governed by slight changes in temperature, knowledge of these variations aid crewmen in keeping their trawls in the more heavily fish-populated waters.

By means of a device attached near the trawl door, the warp will relay changes in the strain between the net and the door, indicating whether the catch is heavy or light.

And in what may prove to be one of its most important uses, the cable can be equipped with lights, fathoms deep, to attract the fish into the trawl's path. EE

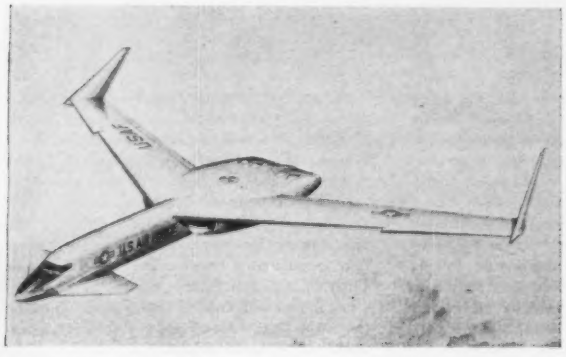
HIPAR Aids Nike-Hercules Weapons System

An advanced high-power long-range acquisition radar which more than triples the defensive capabilities of the present Nike–Hercules weapons system has been developed by the General Electric Company, it was disclosed recently by J. J. Farrell, general manager of the company's heavy military electronics department, Syracuse, N.Y.

The prototype of this new radar is installed at the White Sands Missile Range in southern New Mexico.

Developed under a subcontract with the Bell Telephone Laboratories, Whippany, N. J., this new acquisition radar, known as HIPAR, provides the U. S. Army's improved Nike–Hercules weapons system with the capability to meet the threat posed by hypersonic aircraft, short-range tactical ballistic missiles, and missiles of the size used in an air-to-ground mission, Mr. Farrell said. Western Electric Company is prime contractor for the Nike–Hercules system.

The improved Nike–Hercules weapons system is capable of detecting, tracking, and destroying any air-supported target in existence today, or now known to be on the drawing boards. Equally important, it has demonstrated its defense capabilities against tactical ballistic missiles of the field artillery type. The addition of HIPAR also provides the over-all system with defense capabilities against air-to-surface missiles, and assures high performance despite attempts at sophisticated electronic jamming that could be a threat during the forthcoming decade.



THIS is one version of nuclear-powered aircraft being designed for the Air Force by Convair Division of General Dynamics Corporation at its Fort Worth, Texas, plant. This swept-wing model would be powered by indirect-cycle nuclear engines mounted in the tail.

The new acquisition radar, which has been under development since 1957, is specially designed for use with the improved Nike–Hercules system. It provides long-range coverage on small, supersonic targets and supplies extremely precise azimuth data so that the narrow-beam target tracking radars built by the Western Electric Company can rapidly lock on high-performance missile targets.

In addition to longer range, the high-gain narrow-beam antenna used by HIPAR provides high-angle coverage. Its high-altitude coverage also is appreciably better than most present-day acquisition, aircraft, early warning, and surveillance radars.

To permit the full detection capabilities of the high-gain antenna to be realized despite the presence of enemy jamming, unique moving target indicator (MTI) and receiver circuits have been developed for use with HIPAR. These circuits employ the latest antijamming techniques that provide capabilities not previously possible with conventional MTI techniques.

A new multimegawatt klystron tube, incorporating several significant improvements over previous designs, has been developed to produce the high-power pulsed r-f energy transmitted by HIPAR. Manufactured by the General Electric Company's power tube department in Schenectady, N. Y., the man-sized tube was developed at the company's Microwave Laboratory in Palo Alto, Calif.

During recent months, a detailed study was undertaken to determine the feasibility of repackaging the HIPAR electronic equipment and utilizing a new semiautomatic antenna erection technique to meet the mobility requirements of the Nike–Hercules field army system. This system could be swiftly deployed for use against tactical missiles. Results of this study conducted by General Electric in co-operation with the Bell Telephone Laboratories, Inc., indicate that the HIPAR radar can meet the field army mobility requirements in all areas including air transportability, ground mobility, support requirements, and emplacement time.

Courtesy General Electric Co.

U. S. ARMY'S improved Nike-Hercules system at White Sands Missile Range, N. Mex., showing General Electric-built high-power acquisition radar (HIPAR) housed in large radome and tracking radars built by Western Electric Company, prime contractor for the Nike-Hercules system.

For example, use of a semiautomatic antenna with an automatically erecting "Butterfly" reflector will cut system erection time by 80%. Likewise, the entire radar system, including power generating equipment, can be transported in 10 standard Nike–Hercules-type trailers and be airlifted in four C-124 aircraft. For cross-country mobility, HIPAR can be installed on "Goer"-type vehicles. **EE**

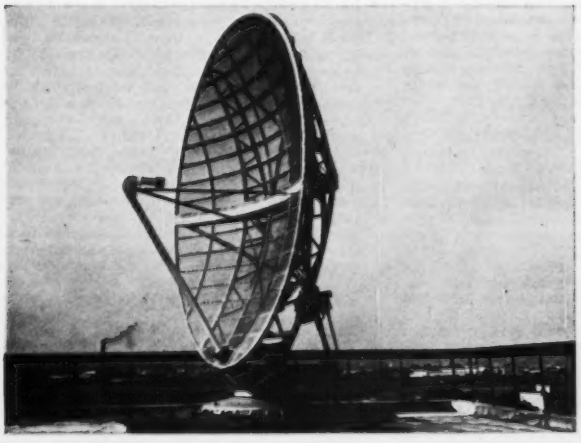
Giant Radar Unit Spots Typhoons 312 Miles Away

A meteorological radar unit has been installed on a remote and rocky headland jutting out into the Pacific Ocean to give Japan an unprecedented degree of protection from one of its most implacable foes —typhoons.

The unit, popularly known as "typhoon radar," will be able to spot typhoons 312 miles away. Most of the radar units hitherto in use in Japan for meteorological purposes have been able to spot typhoons only when they have come within a range of 170 miles.

The vital need for early warning and plotting of typhoons was emphasized with grim force last year when Typhoon Ise Bay hit the Nagoya region of central Japan, killing more than 5,000 people and causing more than 58.587 million yen worth of damage.

With an earlier warning of when and



THIS radar (above, *left*) installed at the Muroto-Misaki Meteorological Station on the island of Shikoku, observes typhonic "eyes" and determines oncoming storms' directions. The giant Toshiba radar unit can detect typhoons more than 300 miles away. The image is projected on the screen in the instrument panel room inside the weather observatory (above, *right*).

where the typhoon was going to hit, proper precautions could have been taken in time and the losses in life and property could have been greatly reduced.

The new radar unit, by spotting typhoons when they are still far out over the Pacific, will help to provide the extra security that advance warning can give. By allowing time for threatened areas to be evacuated and for other precautionary measures to be taken, it could avert disaster.

The new unit was produced by the Tokyo Shibaura Electric Company (Toshiba) and was installed in the meteorological station at Muroto-Misaki in Kochi Prefecture on the island of Shikoku at the end of August.

The new Toshiba typhoon radar unit is officially known as the *TA-2378A* type. It functions on a frequency band of 3,000 mc with a wavelength of 3.9 inches. Its maximum output is 600 kw.

It has a parabolic antenna 15.7 feet in diameter. The radar unit is also equipped with a revolutionary parametric amplifier which helps to give the typhoon radar its great range.

Long-distance observation is also facilitated by an iso-rainfall contouring device that works with an analog computer. This is particularly valuable for observing the "eye" of a typhoon at long range, according to Saburo Makino, chief of Toshiba's Radar Section.

Shigeru Otsuka, chief of the Meteorological Agency's Radar Section, said the new parametric amplifier increases the unit's sensitivity from 99 to 110 db.

Mr. Otsuka, whose section will be responsible for operating the typhoon radar, described it as "epoch-making, not only for its sensitivity but for its great range."

Most of the meteorological radar units hitherto in use in Japan work on a frequency of 5,000 mc, with a wavelength of 2.2 inches and a maximum output of 300 kw.

Units of this type have been in use at the Tokyo, Fukuoka, Tanegashima, Nase, and Okinawa meteorological stations.

EE

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

CLASSIFICATION OF ELECTRON TUBES. By J. Haantjes and H. Carter. The Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1960. 96 pages, 8¼ by 11½ inches, paper, $3.50. In this unusual guide to the principal types of electron tubes, a triple-page classification chart presents a logical system of classification, showing the relationships between the various tubes. This chart is keyed to the text, which contains diagrammatic representations, supplemented by brief descriptions and cut-away views, where necessary, of the various tubes. All illustrations are large, clear, and in color. Introductory chapters give a brief and simple account of the principal phenomena upon which the operation of electron tubes is based.

DIGITAL COMPUTER PRINCIPLES. By W. C. Irwin. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1960. 321 pages, 6¼ by 9¼ inches, bound. $8. This is an introduction for the interested layman, not requiring a background in electronics or mathematics. The emphasis throughout is on principles, illustrated with examples of circuits, devices, and systems familiar to the author but not otherwise unique. The book moves from consideration of details, the basic elements and components, to general description and synthesis of total systems. Symbolic logic is given more emphasis than other subjects, due to the fundamental influence of logic in the behavior of the digital computer.

ELECTROMAGNETIC ENERGY TRANSMISSION AND RADIATION. By R. B. Adler, and others. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1960. 621 pages, 6 by 9¼ inches, bound. $14.50. This is the test for one of the eight subjects of the new undergraduate "core curriculum" being evolved by Massachusetts Institute of Technology in electrical engineering. It treats electromagnetic waves and oscillations by discussing the important linear-system concepts of the time and frequency domains, and the energy-power relations from the theories of lumped circuits and quasi-static fields, extending them to cover "distributed" situations, in which space assumes an importance equal to that of the other independent variables. The objective is to provide a 4-way viewpoint—time, frequency, energy (or power), and space.

THE DYNAMIC BEHAVIOR OF THERMOELECTRIC DEVICES. By P. E. Gray. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1960. 136 pages, 6 by 9¼ inches, bound. $3.50. This is the report of a study of the dynamic behavior of thermoelectric heat pumps and generators, made by means of a small-signal analysis of linear models. This analysis produces small-signal transfer functions that can be used to compute the response of devices in the frequency domain or in the time domain. Here, the small-signal analysis for the heat pump and for the thermoelectric generator and measurement of the small-signal response of a heat pump are described. There is also a chapter examining the modification of the heat-pump analysis to include a temperature-dependent resistivity.

AEROSPACE DICTIONARY. By Frank Gaynor. Philosophical Library, 15 E. 40th St., New York 16, N.Y., 1960. 260 pages, 6¼ by 9¼ inches, bound. $6. This dictionary lists 25 sources, ranging from "Popular Mechanics Press" to the U.S. Atomic Energy Commission, and publications of the years 1956-59. The terms and phrases defined include abbreviations, astronautical and astrophysical terms, recognized designations for types of equipment, material, methods, personnel and organizations. Slang and colloquial terms such as "buzz bomb" and "hot" (for radioactive), nicknames given to space projects ("Mrs. V" and "Able and Baker"), and space vehicles ("Explorer," "Sputnik") are included and so categorized. The definitions are terse and simplified, giving little more than identification in most cases. Inversion is not used, phrases being alphabetized as spoken, as "liquid oxgen explosive," listed under "L."

DICTIONARY OF NUCLEAR PHYSICS. Edited by Hans Rau. W. S. Heinman Imported Books, 400 E. 72nd St., New York 21, N.Y., 1957. 247 pages, 4¾ by 6½ inches, bound. $5. This dictionary contains 5,000 English-German and German-English terms each, used in uranium mining, reactor building, nuclear fission and fusion, isotope research, and in other fields of nuclear physics. Particular consideration has been given to nuclear physical symbols and abbreviations of which more than 600 are included.

PLASTICS TECHNICAL DICTIONARY, Volume 2: German-English. By A. M. Wittfoht. Carl Hanser Verlag, Munich, West Germany, 1959. 573 pages, 4¾ by 7½ inches, bound. 58 DM. This dictionary comprises German-English nomenclature used in the processing, fabricating, and use of plastics. It gives not only literal translation, but attempts to explain linguistic and technical relationships by giving definitions, contexts, cross-references, diagrams, etc. When dealing with terms on test methods and properties, English and German units of measure are given. Bibliographical references are quoted in the case of recent developments or specialized terms. The appendix contains illustrated sections on processes and machinery, a list of general and technical abbreviations, and tables of conversion and comparison.

ELECTRONIC FLASH PHOTOGRAPHY. By R. L. Aspden. The Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1960. 192 pages, 5½ by 9 inches, bound. $8.50. This volume describes current and evolving techniques in the use of the flash discharge tube in photographic and radiographic practice and surveys the present state of the art. A picture of the technique as a whole is presented by means of theoretical outlines of principles together with illustrated examples of practical work. Both British and American sources have been tapped.

HANDBOOK OF GEOPHYSICS. Revised edition. Published by the Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1960. Various pagings, 8½ by 11 inches, bound. $15. Sixty experts collaborated in the preparation of this encyclopedic source of geophysical information, which contains many tables, figures, and references to other publications. Included are papers on model atmospheres and atmospheric pressure, density, composition, and electricity; atmospheric exploratory devices and acoustic propagation; temperature, wind, precipitation, clouds, visibility, the sun, meteors, and the ionosphere; thermal and cosmic radiation; electromagnetic wave propagation and geomagnetism; terrestrial surface parameters and jet aircraft condensation trails.

IONIZATION PHENOMENA IN GASES, FOURTH INTERNATIONAL CONFERENCE-PROCEEDINGS. 1959. Edited by N. R. Nilsson. North-Holland Publishing Company, Amsterdam, The Netherlands, 1960. 2 volumes, 8¼ by 11½ inches, bound. $34.50. These proceedings contain over 200 papers arranged in the following subject categories: Volume 1—Fundamental processes in gas discharges including collision and radiation processes, surface-gas interaction, and ionization in an electric field; and different types of discharges and applications, including glow, arc, and spark discharges and methods of measurement. Volume 2—Theoretical and experimental studies in plasma physics, including transport phenomena, stability problems, interaction between a plasma and charged particles and velocity distribution of the electrons, plasma waves and spectra; and production, confinement, and heating of plasmas, including the longitudinal and the azimuthal pinch, mirror machines and shock-waves. Volumes are continuously paged, author index in volume 2 only.

NAB ENGINEERING HANDBOOK. Edited by A. P. Walker. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1960. Various pagings, bound. $27.50. This book presents the design, construction, and operation of an entire broadcasting system: from antennas and towers, through transmission lines, transmitters, and studio-transmitter links, to studio lighting, remote pick-up, and national network facilities. Forty-seven authorities cover wave propagation, absorption, color television facilities, field strength measurement techniques, video-tape recordings, transistor applications, television translators and boosters, remote control, automatic logging techniques, and stereophonic broadcasting. Applicable Federal Communication Commission regulations, and standards are also given.

NON-CRYSTALLINE SOLIDS. Edited by V. D. Fréchette. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1960. 536 pages, 6 by 9¼ inches, bound. $15. These papers were presented at the fourth (1958) of a series of conferences sponsored by the Division of Physical Sciences of the National Academy of Sciences-National Research Council to enable invited experts to interchange information on a chosen topic. Previous conferences discussed phase transformation in solids (1948), imperfections in crystals (1950), and solid surfaces (1952). The papers in this

volume are arranged in four subject groups, dealing with noncrystalline materials from the standpoint of the scattering of radiation, electronic structure, relaxation phenomena, and the structure and properties of special systems. Contributions were from Canada, England, France, Switzerland, the Netherlands, and the United States.

ORGANIZING THE TECHNICAL CONFERENCE. By H. S. Kindler. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y., 1960. 139 pages, 6¼ by 9¼ inches, bound. $6. Being a guide for those wishing to plan or participate in a technical conference, the discussion is focussed on the organization of smaller gatherings. All conference techniques described have been successfully tried, though some are more experimental than others. Attention is given to the purpose and types of conferences, initial planning; program development; auxiliary, supporting, and servicing activities; promotion and public relations; documentation; and evaluation and follow-up activities.

PROFESSIONAL ENGINEER'S EXAMINATION QUESTIONS AND ANSWERS. By W. S. La Londe, Jr. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1960. 589 pages, 5½ by 8¼ inches, bound. $7.50. This is the second edition of a useful book which reviews engineering fundamentals in preparation for professional examinations, using mainly past examinations given by various State Boards of Examiners as sources for problems.

PROGRESS IN AUTOMATION, Volume I. Edited by A. D. Booth. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 1960. 226 pages, 5¾ by 8¾ inches, bound. $8.50. This first volume of a proposed series contains eleven papers from leading British experts in the United Kingdom in devices for industrial control. Following an introduction to the field, with a brief historical note and definition of terms, are six papers covering analog conversion techniques, process control systems, position control of machine tools, the inductosyn, nucleonic gauges, and nucleonic fluid density measurement. Five papers on applications deal with the Ferranti and E.M.I. systems of machine tool control, control in the manufacture of steel strip, and automatic inspection.

THE RELAY GUIDE. By R. W. Auger. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N.Y., 1960. 383 pages, 8½ by 11¼ inches, bound. $10. This is a compendium of the electromechanical relays marketed in the United States by approximately 200 manufacturers. Each relay is described by means of a detail drawing, specifications, operating characteristics, manufacturer, and often installation characteristics. The relays are classified according to type with multitype relays included in the classification of their most specialized use and cross-referenced from other uses. Variations in a type are given in tables and lists at the entry for the basic type. There is an index of alternate characteristics and an index of manufacturers.

SEMICONDUCTOR ABSTRACTS, Volume V —1957 issue. Edited by C. S. Peet. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1960. 449 pages, 8½ by 11¼ inches, bound. $12. Some 1,700 references are listed in the new volume of this useful and thorough compilation. Most of the entries are from 1957 with a scattering of earlier ones from a few foreign journals. Through intensive editing, more cross-references, reduction of duplication, and elimination of phenomena of lesser relevance like organic ferroelectrics and solution luminescence, this edition of the abstracts is smaller and the coverage more intensive than previous ones. Arrangement is by subject with four main divisions: elemental semiconductors, compound semiconductors, theory, and general applications.

THE THEORY OF HEAT RADIATION. By Max Planck. Dover Publications, Inc., 920 Broadway, New York 10, N.Y., 1959. 224 pages, 5½ by 8 inches, paper. $1.50. This is a reprint of the 1914 translation of the second edition (1913) of Planck's "Waermestrahlung," in which he sets forth his hypothesis of quanta, as part of his special theory of radiation. This theory is presented as a possible way of accounting for the processes of radiant energy from the same point of view as for the processes of molecular motion. The treatment starts from the simple known experimental laws of optics, and advances, by gradual extension and by addition of the results of electrodynamics and thermodynamics, to the problems of the spectral distribution of energy and irreversibility.

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ENGINEERING Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.

TRANSFORMERS AND GENERATORS FOR POWER SYSTEMS. By R. Langlois-Berthelot. Philosophical Library, Inc., 15 E. 40th St., New York 16, N.Y., 1960. 541 pages, 5¾ by 8¾ inches, bound. $12. In this British translation of the original French text both transient and steady-state conditions are studied. In addition to chapters dealing with and developing the fundamentals, there are survey chapters giving general treatment to practical aspects of special problems. The volume is divided into two books. Book 1 discusses the transformer, covering electromagnetic theory, windings, insulation, losses, voltage regulation, and phase connection, with survey chapters on abnormal conditions, special types of transformers and transformer construction, technical literature, and the particular interests of the specification and the operating engineer. Book 2 deals with the synchronous machine under similar relevant headings.

TRANSISTOR CIRCUIT ANALYSIS AND DESIGN. By F. C. Fitchen. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N.J., 1960. 356 pages, 6¼ by 9½ inches, bound. $9. This is a text for juniors or seniors or for technical institute students with a background of a-c and d-c circuit theory and elementary vacuum-tube electronics. It includes coverage of equivalent circuits and their parameters, single-stage, multistage, large-signal and communications amplifiers, feedback, and communications and pulse circuits and systems, as well as the general introductory material on transistors as isolated components and as important parts of the practical electronic circuit.

THE USES OF ELECTRICITY IN THE OIL INDUSTRY. Edited by E. A. Reeves. Ernest Benn, Ltd., London, England, 1960. 296 pages, 6¼ by 9¼ inches, bound. $10. This is a reference book for electrical and power engineers in the petroleum industry, and for manufacturers of electric equipment for use in the industry, which details the practices adopted by British oil companies. One chapter also describes where these differ from continental and North American practices. Distributed in America by Professional Books Inc.

EFFECTIVE REPORT WRITING. By N. B. Sigband. Harper & Brothers, 49 E. 33rd St., New York 16, N.Y., 1960. 688 pages, 5¾ by 8½ inches, bound. $6.75. This book is designed to serve as a text in communication courses or as a guide for professional personnel in business, government, and industry. For the inexperienced there are chapters on writing style, the organization and analysis of data using both primary and secondary sources, and the actual construction of the report. For advanced students there are descriptions and examples of reports in various specialized areas, such as accounting, engineering, and government. Oral reports and letters of application also are described, and there is a detailed section on business letter writing.

ELECTRICAL SYSTEMS DESIGN. By J. F. McPartland. Second edition. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1960. 208 pages, 8½ by 11¼ inches, bound. $7.75. This second edition includes a wider variety of design details, illustrated and analyzed in terms of modern design standards and the National Electrical Code. It covers residential wiring, selection and layout of lighting equipment, application of electric heating and air conditioning, and design of signal and communication circuits and layouts as well as preparation of plans and specifications in the design of total electric systems for industrial, commercial, and institutional buildings.

BASIC PRINCIPLES OF NUCLEAR SCIENCE AND REACTORS. By A. M. Jacobs, and others. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., 1960. 262 pages, 6¼ by 9¼ inches, bound. $6.50. Falling midway between theory and practical approach, this discussion presents qualitative developments of the basic theory of fission chain reactions, without mathematical rigor, and then uses these concepts to analyze existing reactor systems. The opening chapters introduce relevant concepts of modern physics, and the closing chapters discuss subjects related to the operation and use of nuclear reactors. Appendices include a chart of the nuclides, and tables of physical constants and conversion factors.

SELECTED SEMICONDUCTOR CIRCUITS HANDBOOK. Edited by Seymour Schwartz. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. Various pagings, 6¼ by 9¼ inches, bound. $12. Emphasizing "building-block" circuitry, this aid in the design of circuits for electronic equipment and systems presents the design philosophy and describes the pertinent characteristics of each circuit selected: It includes direct-coupled, low-frequency and high-frequency amplifiers, oscillators, a-c to d-c power suppliers, power converters, logic, magnetic and transistor circuits, and small-signal nonlinear circuits.

MOLECULAR STRUCTURE. By J. C. D. Brand and J. C. Speakman. St. Martin's Press, Inc., 175 Fifth Ave., New York 10, N. Y., 1960. 300 pages, 6 by 9¼ inches, bound. $8. This general account of the application of physical methods to the analysis of molecular structure, written for the graduate and research levels, emphasizes principles rather than practice. It includes discussions of symmetry, elementary wave mechanics, rotation and vibration of molecules, nuclear resonance spectra, crystal structure analysis and electron diffraction.

THE SCATTERING AND DIFFRACTION OF WAVES. By R. W. P. King and Tai Tsun Wu. Harvard University Press, Cambridge, Mass., 1959. 218 pages, 5¾ by 8¾ inches, bound. $6. This monograph is intended to be a fairly comprehensive summary of research carried out primarily at Harvard, in those aspects of diffraction and scattering of electromagnetic waves that properly fall under the broad heading of reflections from surfaces of complex shape. Surfaces considered include circular cylinders, spheres, disks, and strips. Other topics covered include transmission through an aperture, and measurement of the back-scattering cross section of obstacles and of their diffracted fields.

MATHEMATICAL METHODS FOR DIGITAL COMPUTERS. Edited by Anthony Ralston and H. S. Wilf. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1960. 293 pages, 7¼ by 10½ inches, bound. $9. The first chapter describes methods of generation of elementary functions on digital computers. The remaining chapters each present a mathematical discussion of a particular method followed by related papers of special interest, all by authors in close contact with latest developments. The areas covered in these chapters are: matrices and linear equations; ordinary differential equations; partial differential equations; and statistics. The final chapter contains six papers on miscellaneous methods, including those for numerical and multiple quadature, and Fourier and network analyses.

LEXIKON DER HOCHFREQUENZ-, NACHRICHTEN- UND ELEKTROTECHNIK, Volumes 3 and 4. Edited by Curt Rint. Verlag Technik, Berlin, Germany, 1959. Various pagings, 4½ by 6½ inches, bound. Price: DM

28.75 per volume. Volumes 3 and 4 of an encyclopedic polyglot dictionary of high-frequency, communication, and electrical engineering terms. In addition to giving the corresponding terms in German, Russian, English, and French, brief explanations in German are provided, with illustrations and mathematical formulas in some instances. So far four volumes have been published, covering A to Z. The final volume is to be an index of all terms in English, French, and Russian.

IMPULSTECHNIK. By Frank Früngel. Akademische Verlagsgesellschaft, Leipzig, West Germany, 1960. 575 pages, 6¼ by 8¾ inches, bound. 54 DM. Under the title "impulse techniques" the author deals with the generation and application of capacitor discharges. Separate chapters cover the transformation of capacitor-stored energy into current surges, voltage surges, heat pulses (welding), light pulses (e.g. stroboscopy), acoustic pulses, speak erosion, discharges, etc. Preliminary chapters cover general or basic aspects, and the final 100 pages are devoted to measurement methods for the various types of general impulses.

FLÄCHENTRAGWERKE. By Karl Girkmann. Springer-Verlag, Vienna, Austria, 1959. 632 pages, 6½ by 9¼ inches, bound. $17.15. This is a detailed treatment of the elastostatics of load-bearing structures, which discusses the important problems involved in the calculations of stresses and deflections in plates, shells, and prismatic structures. For practical use, the analytic solution of a wide range of such problems is carried out, with particular attention to the underlying principles. An extensive list of references accompanies each of the five main sections.

ELEKTRISCHE ANTRIEBE. By Adolf Leonhard. Second edition. Ferdinand Enke Verlag, Stuttgart, West Germany, 1959. 283 pages, 6½ by 9½ inches, bound. DM 43. This mathematical study of the characteristics and operation of electric drives covers the common aspects of all electric drives: starting, proper selection of type and size of the motor, influence of the working load on the motor, etc. Practical applications are then discussed with many illustrative examples.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

REACTOR HANDBOOK. Volume I, Materials. This is the first volume of the Atomic Energy Commission's revised and enlarged 1,200-page second edition. It contains 53 chapters with over 1,000 tables and illustrations and was prepared by 105 of the nation's foremost reactor scientists and engineers. There are extensive bibliographical references for each chapter. It is divided into seven parts: General, Fuel Materials, Cladding and Structural Materials, Control Materials, Moderator Materials, Coolant Materials, and Shielding Materials. The book includes an appendix of Constitutional Diagrams of Binary Alloy Systems. The volume is available for $36.50 from Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.

PENETRATION OF CHARGED PARTICLES IN MATTER. The National Academy of Sciences has published proceedings of a conference held in September 1958 by a subcommittee of its Committee on Nuclear Science. Edited by Edwin A. Uehling of the University of Washington, the 25 papers presented cover topics ranging from the reliability of experimental data to new approaches in the theoretical description of energy loss mechanism. These are divided into sections on stopping power and range, recent developments in the theory of stopping power, charge changing collisions, atomic and molecular scattering, ionization in gases by high-energy particles, and microscopic and macroscopic energy loss distributions. This volume may be purchased from the Printing and Publishing Office of the Academy-Research Council, 2101 Constitution Ave., Washington 25, D. C. Price $2.

1960 IRE WESCON CONVENTION RECORD. Papers presented at the Western Electronic Show and Convention provide an invaluable record of the latest important developments in virtually every branch of the electronics field. They have been made available in a 1,000-page volume, issued in eight parts: Antennas, Microwaves; Circuits, Device Applications; Electron Devices, Microminiaturization; Computers, Man-Machine Systems; Space, Telemetry, Instrumentation; Air Traffic Control, Military Electronics, Reliability; Broadcasting, Communications; Management, Writing and Speech. Price for the complete set is $11.70 for the IRE members, $31.20 for libraries and subscription agencies, $39.00 for nonmembers. Individual parts may also be ordered. Available from The Institute of Radio Engineers, Inc., 1 E. 79th St., New York 21, N. Y.

PROCEEDINGS OF THE NATIONAL INVENTIONS AND NEW PRODUCTS CONFERENCE AND EXHIBITION. This 175-page volume contains the papers of 25 speakers who attended the conference which was held in Cleveland in June. It is available at $3 per copy from the Cleveland Engineering Society, 3100 Chester Ave., Cleveland 14, Ohio.

NEMA STANDARDS PUBLICATION — TRANSFORMERS, REGULATORS AND REACTORS. The Transformer Section of the National Electrical Manufacturers Association (NEMA) with the co-operation from other allied industry organizations has compiled all present transformer standards in this new publication. The text brings together information on transformer standards approved by the American Standards Association (ASA) and those NEMA transformer standards which still are awaiting ASA approval. Included among the various standards are those for distribution, power and regulating transformers, regulators and reactors, and such special-purpose transformers as those used in unit substations, electric arc furnaces, and industrial rectifiers. The material is divided into 20 separate parts and includes general standards, test code, terminology, and apparatus standards. This publication No. Tr 1-1960 is available from NEMA Headquarters, 155 E. 44th St., New York 17, N. Y., at $1 per copy.

AMERICAN STANDARDS. *Electrical Diagrams Y14.15-1960*, newest section of American Standard Drafting Manual, contains definitions and general information applicable to most of the commonly used electrical diagrams. It also includes detailed recommendations on preferred practices for use in the preparation of these diagrams. The information in the standard pertains to electrical diagrams of the type used by the electronics and communications industries. Price $1.50 per copy. *American Standard Specifications for Industrial Accident Prevention Signs Z35.1-1959* deals with safety sign "language" and lays particular stress upon the need for uniformity, at all industrial levels, of accident prevention signs. The objective is to make workers familiar with the necessary sign designs, no matter where they may work. Standardization of design and color is the key to recognition. Price $1.35 per copy. Both of these standards are available from American Standards Association, 10 E. 40th St., New York 16, N. Y.

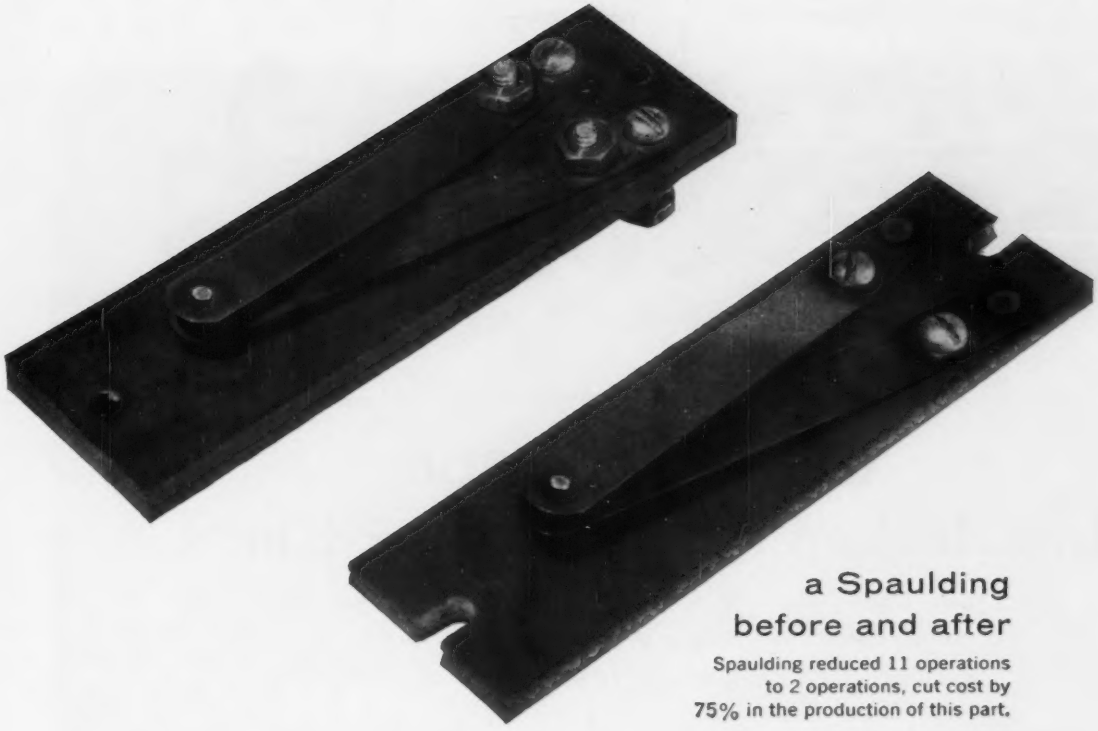
NBS PUBLICATIONS. The National Bureau of Standards (NBS) has made the following publications available: *Conductive Flooring for Hospital Operating*. Sparks which can result from the accumulation of static electricity constitute a hazard in locations where explosive vapors are present. The most effective means of reducing this hazard consists in keeping the electrical resistance between all objects in the area so low that dangerous voltages are never attained. This 16-page NBS Monograph 11 studies the characteristics and performance of conductive flooring materials as a primary factor in solving this problem. Price 20¢. *A Method for the Dynamic Determination of the Elastic, Dielectric, and Piezoelectric Constants of Quartz*, NBS Monograph 9, includes chapters on general considerations, longitudinal vibration of rectangular bars, thickness vibration of quartz plates, and determination of the constants of quartz. Price 15¢. *New Description of Thorium Spectra*, NBC Monograph 17, price 65¢. These publications may be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

OTS REPORTS. The U. S. Office of Technical Services (OTS) has released the following reports for sale to the public: *Research on Field Emission Cathodes PB 161526*, price $2.75, describes a simplified method for predicting the electrical performance of field emission cathodes; *A Survey of Solid-State Light Amplifiers and Allied Devices PB 161465*, price $1.75, discusses electroluminescence and the application of this phenomenon to light-amplifier panels and other devices; *Organic Semiconductors PB 161459*, price $1.25, contains results of experiments with organic semiconductors in molecular addition compounds, solids with elements or compounds capable of charge transfer by oxidation-reduction mechanism, and conductivity and mobility measurements. A summary of the U. S. Navy's progress in developing a digital-to-analog decoder using closed-loop sample data techniques is presented in two reports: *The Analysis and Design of Digitally-Controlled Instrument Servos PB 161020*, price $2.25, discusses the establishment of a mathematical model of the digital to analog; *A Simulator Study of Two Digitally-Controlled Instrument Servos PB 161021*, price $2, establishes experimental verification of the mathematical model described above. The preparation of thin films by pyrolytic deposition and other means for potential use in composite molecular electronics is explained in *Research on the Pyrolytic Deposition of Thin Films PB 161117*, price $1.25, and *A Direct-Reading Six-Decade Precision Frequency Generator, PB 151158*, price 50¢, describes the development of a miniature generator which measures less than 13 by 15 by 6 inches. All of the foregoing reports may be ordered from OTS, U. S. Department of Commerce, Washington 25, D. C.

MECHANICAL DESIGN OF HYDRO PLANTS. This is the third and final volume of a 3-volume series relating the design experience of the Tennessee Valley Authority (TVA) in civil, electrical, and mechanical work on hydroelectric projects, (following *Civil and Structural Design* and *Electrical Design of Hydro Plants*) and the sixth of a series of special technical reports covering important phases of engineering and construction work common to all projects built by TVA. The report includes summaries of TVA's first 25 years of engineering and construction achievements; hydraulic turbines; experience with auxiliary power generators; elevators; compressed air systems; oil systems and handling; heating, ventilating, and air conditioning; piping design; etc. It contains 986 pages, 368 illustrations, 27 tables, and 58 design drawings. Copies may be purchased from the TVA Treasurer's Office, Knoxville, Tenn., for $3.75.

DIMENSIONS OF ELECTRONIC TUBES AND VALVES. This Fourth Supplement to Publication 67 by the International Electrotechnical Commission includes bases, outlines, and caps. It is available from the Central Office, 1, rue de Varembé, Geneva, Switzerland, Price Sw. Fr. 6 per copy plus postage.

IES RECOMMENDED PRACTICE FOR OFFICE LIGHTING. This 36-page booklet prepared by the Illuminating Engineering Society (IES) Committee on Office Lighting is the latest in a series of revised practices for office lighting providing material that is particularly useful to architects, consulting lighting engineers, lighting engineers, and specialists for electric utilities and manufacturers, decorators, etc. Beginning with a general analysis of the office lighting problem, under specific headings the report describes office seeing tasks, the influence of lighting on seeing, quality and quantity of illumination, and the influence upon lighting and seeing of environmental factors such as room and equipment finishes and color. Various daylighting and electric lighting systems and controls are also described. Copies of the booklet may be obtained from Publications Office, Illuminating Engineering Society, 1860 Broadway, New York 23, N.Y.



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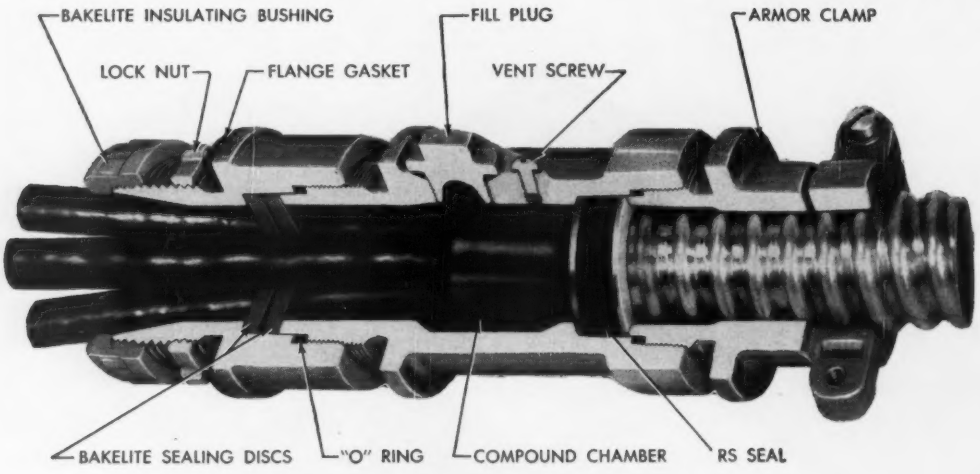

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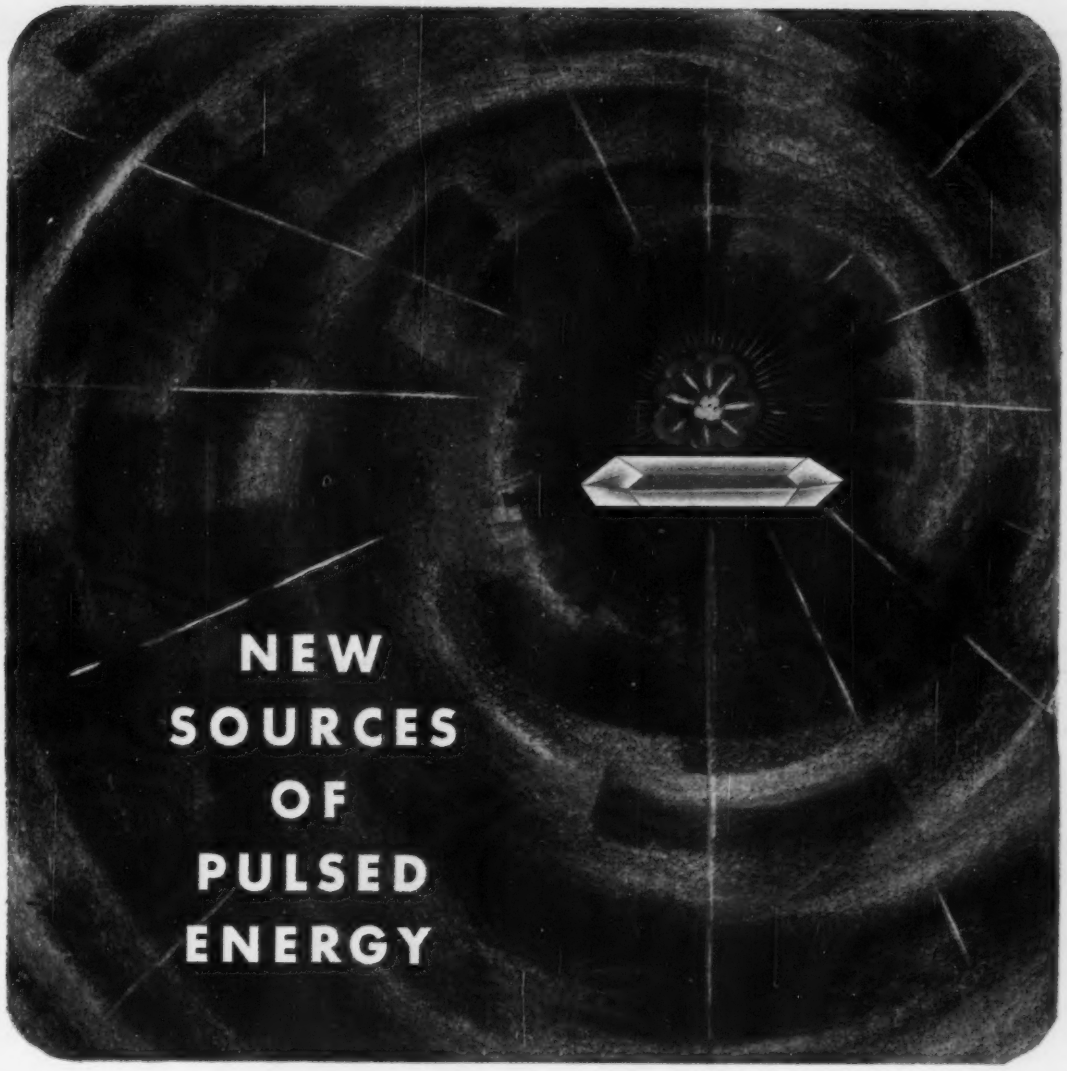

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It might sound like splitting hairs to talk a few hours' time saving on a job as expensive as building a high voltage pothead. Yet, it's a fact, these few hours are very valuable!

Modern O-B capacitor-graded potheads have many components that are factory assembled - - many more that are considerably simplified. The construction crew can leave the job at quitting time with an O-B pothead completed.

This means that the oil-filled cable need not be under temporary seal over night. Risk of exposure is cut materially. Ask your cable man what it means to clean up a pothead in a day's time, and have it under permanent seal by sun-down. Here is where the time saving of O-B potheads really pays off.

This is just one of many features of O-B's new terminal equipment. It will pay you to know the whole story before you plan any new construction. You can get it from your O-B representative or by writing us direct.

OHIO BRASS COMPANY, MANSFIELD, OHIO

Ohio Brass

PORCELAIN INSULATORS • LINE HARDWARE • CAPACITORS • LIGHTNING ARRESTERS
BUSHINGS • HOLAN TRUCK-MOUNTED POWER DEVICES AND BODIES • BRONZE VALVES

HOLAN

100007-H

how to split a SPLIT SECOND

New HUGHES® nanosecond diodes switch 50 times faster than standard germanium diodes. If your circuits require faster response, faster recovery, with greater accuracy, you can solve your problem with Hughes nanosecond diodes.

Hughes nanosecond germanium diodes are designed to make today's circuits better — and tomorrow's possible. They combine the most wanted parameters into one subminiature component. They switch 50 times faster than the usual germanium diode; they have conductances 50% higher; and they have rectification efficiencies greater than 70%. They have higher Q and faster recovery (both forward and reverse), which give your circuits greater accuracy and extremely low transient losses.

These new semiconductors were created especially for high-speed computer logic, high-frequency transistor circuits, extremely fast reference switching, and low-noise, low-level RF modulation and demodulation. If you're working with sophisticated circuitry with exacting requirements, the Hughes Semiconductor sales engineer in your area is a good man to know. Call him.

Or write Hughes Semiconductor Division, Marketing Department, 500 Superior Avenue, Newport Beach, California.

SPECIFICATIONS

Types	Minimum Forward Voltage @ 100 MA (V)	Minimum PIV @ I_R = 100μA (V)	Max. Rev. Current @ Specified Voltage (μA)	(V)	Min. Rectification Efficiency JAN (%)	Maximum Capacitance At 0 Bias @ 100Kc (pf)	Maximum Dynamic Impedance @ 1mAdc & 0.1mA RMS (ohms)	MAX. REVERSE RECOVERY T_{RR} to R (msec)	(KΩ)	Recov. Circ. Switching (R_L = 100Ω) I_F (mA)/V_R
HD2963	.65	7	10	5	65	4	40	6	2	10/-6
HD2964	1.00	20	10	5	60	2	60	3	2	10/-6
HD2967	.75	4	40	2.5	65	4	40	6	1	3/-3
HD2968	1.00	6	40	2.5	60	3	80	4	1	10/-6

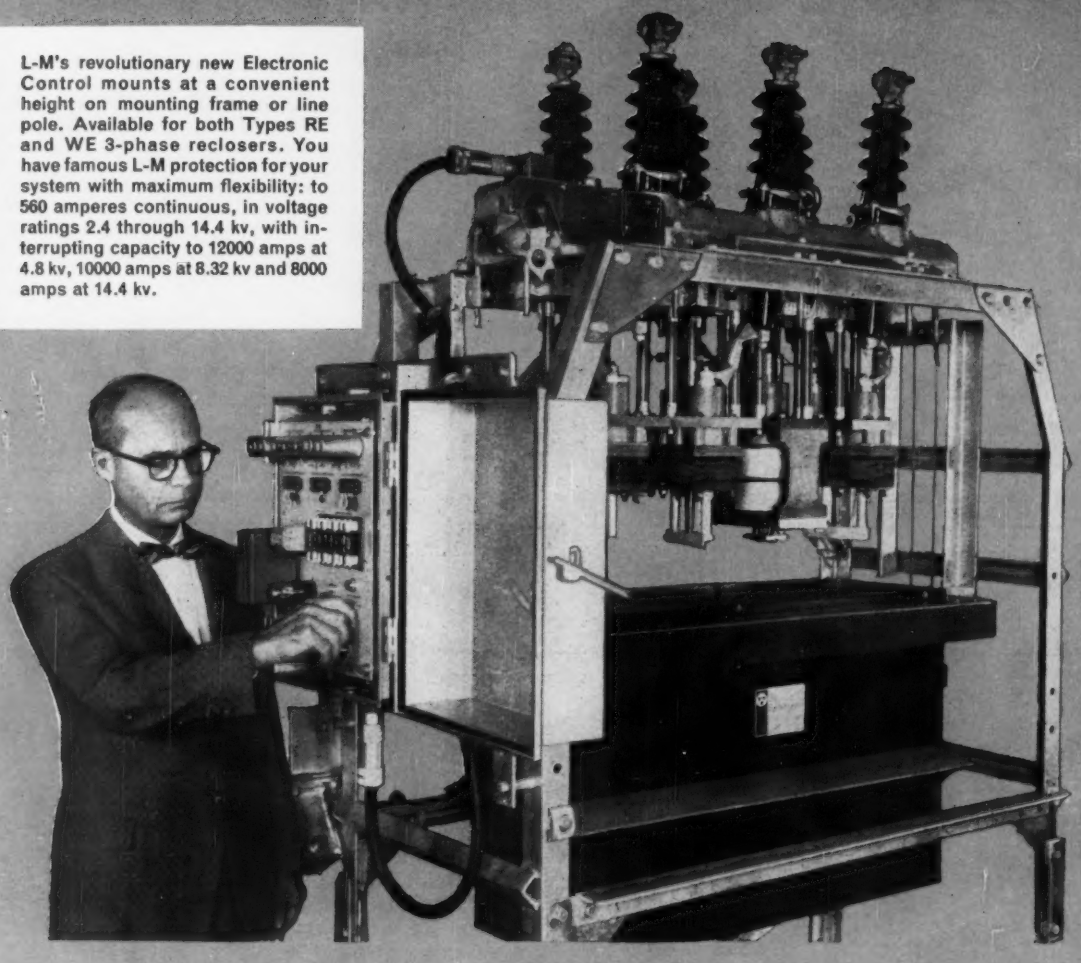
Note: The recovery characteristic was measured on the lumatron sampling scope.

Creating a new world with ELECTRONICS

HUGHES

SEMICONDUCTOR DIVISION
HUGHES AIRCRAFT COMPANY

L-M's revolutionary new Electronic Control mounts at a convenient height on mounting frame or line pole. Available for both Types RE and WE 3-phase reclosers. You have famous L-M protection for your system with maximum flexibility: to 560 amperes continuous, in voltage ratings 2.4 through 14.4 kv, with interrupting capacity to 12000 amps at 4.8 kv, 10000 amps at 8.32 kv and 8000 amps at 14.4 kv.

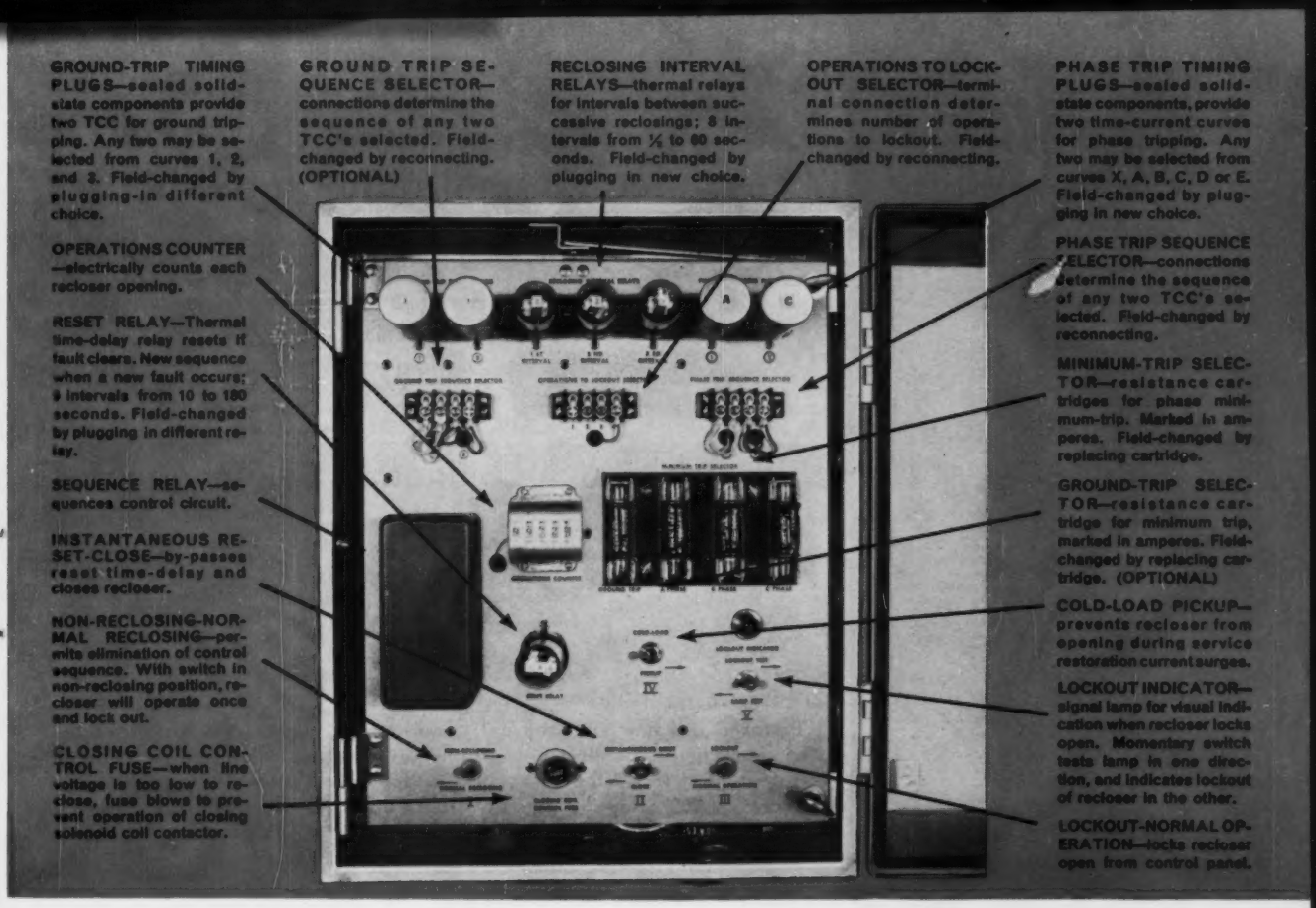


Outstanding Features of L-M Reclosers

- Lowest possible cost—no other device can match L-M's recloser protection for the same money.
- Simple installation—when controls are adjusted you just connect circuit conductors to bushing terminals and recloser is in operation.
- Wholly-contained—requires no auxiliary power supplies or relays whether installed in substation or on pole top.

Now New L-M Electronic Control Adds:

- Greater control flexibility—minimum trip current, number of operations to lockout, number of fast and retarded operations and time-current characteristics field-changed without untanking or interrupting service.
- Greater Application Flexibility—the basic Electronic control is complete with all control possibilities built in except optional ground trip. All possible protection is contained in one unit.
- Complete test-ability—control may be tested with 120 volts AC with very low current.
- Ground Level Operation—Control panel may be mounted independent of recloser.
- Simplified Coordination—L-M Electronic control offers special operating characteristics apart from time-current characteristics presently offered.


GROUND-TRIP TIMING PLUGS—sealed solid-state components provide two TCC for ground tripping. Any two may be selected from curves 1, 2, and 3. Field-changed by plugging-in different choice.
OPERATIONS COUNTER—electrically counts each recloser opening.
RESET RELAY—Thermal time-delay relay resets if fault clears. New sequence when a new fault occurs; 9 intervals from 10 to 180 seconds. Field-changed by plugging in different relay.
SEQUENCE RELAY—sequences control circuit.
INSTANTANEOUS RESET-CLOSE—by-passes reset time-delay and closes recloser.
NON-RECLOSING-NORMAL RECLOSING—permits elimination of control sequence. With switch in non-reclosing position, recloser will operate once and lock out.
CLOSING COIL CONTROL FUSE—when line voltage is too low to reclose, fuse blows to prevent operation of closing solenoid coil contactor.
GROUND TRIP SEQUENCE SELECTOR—connections determine the sequence of any two TCC's selected. Field-changed by reconnecting. (OPTIONAL)
RECLOSING INTERVAL RELAYS—thermal relays for intervals between successive reclosings; 8 intervals from ½ to 60 seconds. Field-changed by plugging in new choice.
OPERATIONS TO LOCKOUT SELECTOR—terminal connection determines number of operations to lockout. Field-changed by reconnecting.
PHASE TRIP TIMING PLUGS—sealed solid-state components, provide two time-current curves for phase tripping. Any two may be selected from curves X, A, B, C, D or E. Field-changed by plugging in new choice.
PHASE TRIP SEQUENCE SELECTOR—connections determine the sequence of any two TCC's selected. Field-changed by reconnecting.
MINIMUM-TRIP SELECTOR—resistance cartridges for phase minimum-trip. Marked in amperes. Field-changed by replacing cartridge.
GROUND-TRIP SELECTOR—resistance cartridge for minimum trip, marked in amperes. Field-changed by replacing cartridge. (OPTIONAL)
COLD-LOAD PICKUP—prevents recloser from opening during service restoration current surges.
LOCKOUT INDICATOR—signal lamp for visual indication when recloser locks open. Momentary switch tests lamp in one direction, and indicates lockout of recloser in the other.
LOCKOUT-NORMAL OPERATION—locks recloser open from control panel.

L-M's New Electronic Control Provides Greater Flexibility For Reclosers

Relay, System Protection and Substation Engineers will find that the new Type RE and WE Reclosers offer the ultimate in coordinated system protection.

by **N. K. DELANEY**
Product Manager,
Switchgear and Capacitors
Line Material Industries

Oil Circuit Reclosers as developed by Line Material some years ago have been universally accepted as tremendously efficient, cost-saving protection for distribution lines and substations.

One reason for L-M's outstanding leadership in reclosers has been the L-M-developed hydraulic control, which is extremely dependable, and well accepted.

Today Line Material announces another revolutionary new engineering development—the L-M *Electronic* Control.

The *Electronic* control consists of a solid-state transistorized sensing and control device: time-delay relays for resetting and reclosing; provisions for ground current tripping; test and control switches; and plug-in components to provide for changing time-current curves and sequences without service interruptions. The L-M Electronic control provides greater flexibility, greater accessibility, and a wider choice of time-current curves than have been available even with L-M's outstanding hydraulic control.

Now Get Electronic Coordination

Get complete details on this outstanding improvement by Line Material in automatic line protection. Ask the L-M Field Engineer for Product Information Bulletin CR1WE, and ideas on how you can take advantage of this remarkable new development in oil circuit reclosers. Call the nearest L-M office; or phone or write Line Material Industries, Milwaukee 1, Wisconsin. In Canada: CLM Industries, McGraw-Edison (Canada) Limited, Toronto 13, Canada.

LINE MATERIAL® Industries

McGRAW-EDISON COMPANY

Reclosers, Sectionalizers, and Oil Switches

McGRAW-EDISON

DISTRIBUTION TRANSFORMERS • RECLOSERS, SECTIONALIZERS AND OIL SWITCHES • FUSE CUTOUTS AND FUSE LINKS • LIGHTNING ARRESTERS • POWER SWITCHING EQUIPMENT
PACKAGED SUBSTATIONS • CAPACITORS • REGULATORS • OUTDOOR LIGHTING • LINE CONSTRUCTION MATERIALS • PORCELAIN INSULATORS • FIBRE PIPE & CONDUIT

One of a series

New Light on a Compound Semiconductor

Pictured is a new and unusual transistor . . . made from a *compound* semiconductor. Its electronic properties are greatly affected by *light*. It is a *field-effect* transistor having input impedances up to 100 megohms (versus 1,000 ohms for junction transistors). Its unique combination of properties has enabled it to perform some novel circuit functions not possible with other transistors.

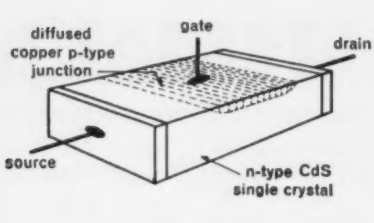
Still in the early experimental stage, this phototransistor is a tangible result of the General Motors Research Laboratories' program on semiconductors — particularly the group II-VI compound, cadmium sulfide. Behind its development lies the steady accumulation of (1) know-how in crystal growing, doping, and contact preparation and (2) information about CdS's intriguing solid state properties (red or green luminescence, high photoconductivity, short relaxation times, etc.).

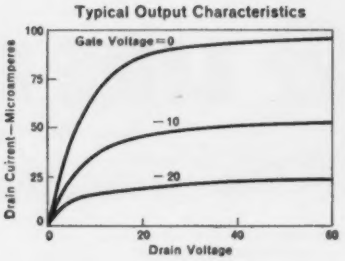
For the researcher, this three-terminal device is adding a new dimension to the fundamental understanding of semiconductors. For instance: GM Research scientists have uncovered the important role of photo-generated holes in modulating the conductance of this intrinsic semiconductor and have determined the hole drift mobility through a new theoretical analysis.

These semiconductor investigations illustrate the dual aim of GM Research: contributions to the science, advances in the technology of important new subject areas. Such research is the initial step in General Motors' continuing quest for "more and better things for more people."

General Motors Research Laboratories

Warren, Michigan





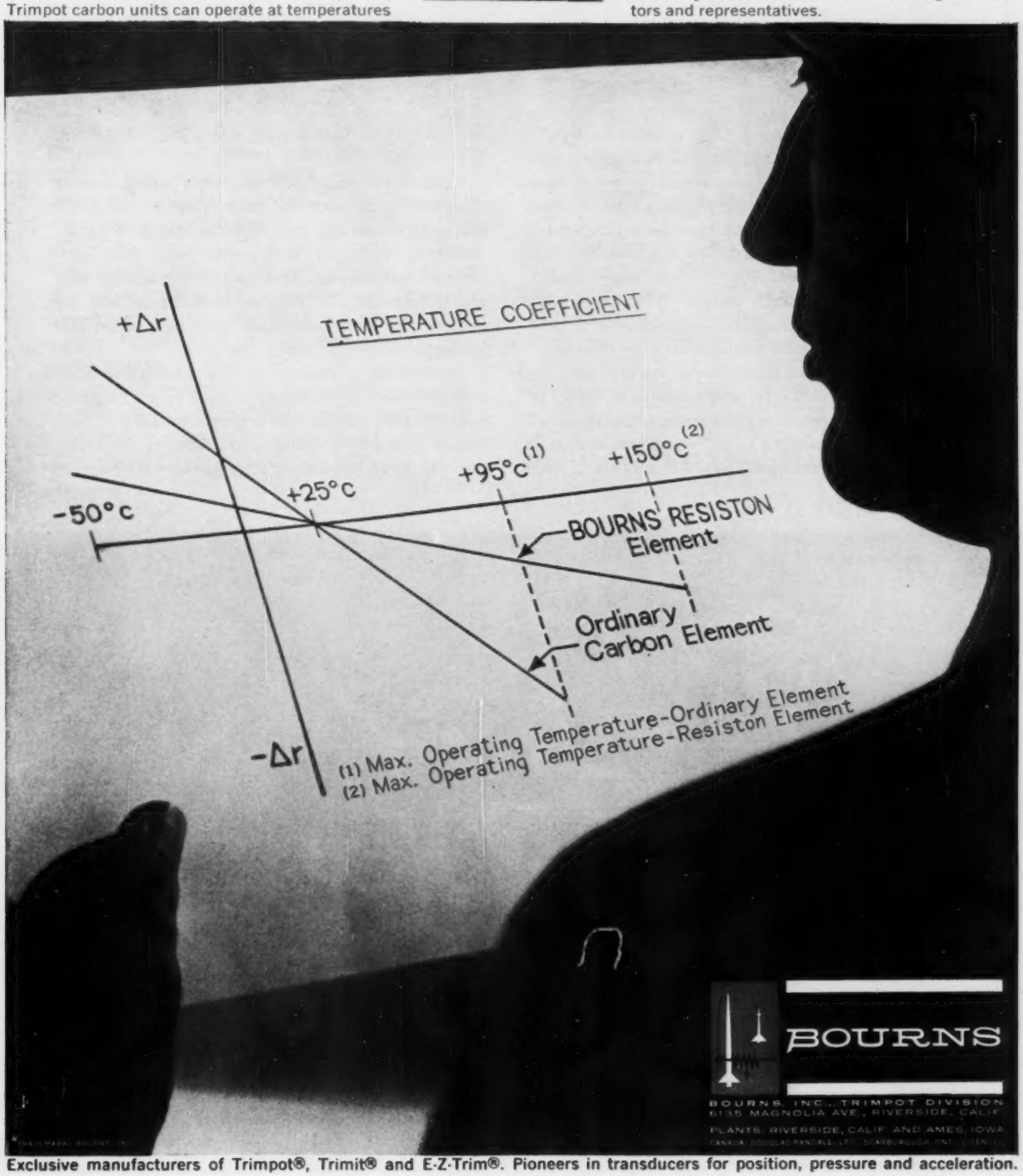
At Last—High Reliability in Carbon-Film Potentiometers!

NUMBER 10—RELIABILITY SERIES

Bourns Trimpot® carbon-film potentiometers now offer you twice the stability of any carbon unit heretofore available... at temperatures as high as 150°C. Now, for the first time, you can incorporate high-resistance, infinite-resolution potentiometers in your circuit without sacrificing reliability. The reason: Resiston®, a remarkable new carbon element that virtually eliminates the problems normally caused by extremes of temperature and humidity.

Thanks to this exclusive Bourns development, Trimpot carbon units can operate at temperatures up to 150°C—with resistance shift only half that of ordinary carbon elements. In addition, they far exceed the requirements of Mil-Specs for humidity and MIL-R-94B.

Trimpot Resiston units are available from factory and distributor stocks with three terminal types... three mounting styles ...and standard resistances ranging from 20K to 1 Meg. Resiston elements are available in most Bourns configurations. Write for the new Trimpot summary brochure and list of stocking distributors and representatives.



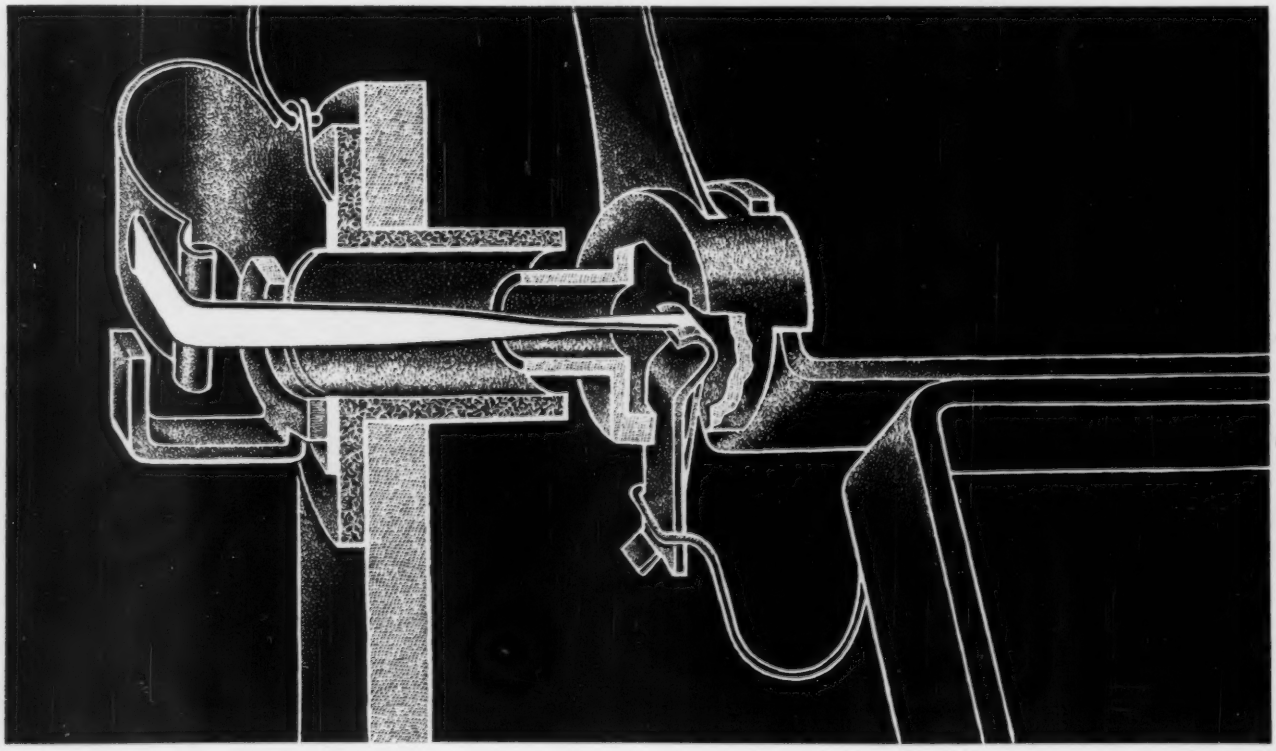
Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®. Pioneers in transducers for position, pressure and acceleration.

Westinghouse extends "TAUT BAND SUSPENSION" to full line of

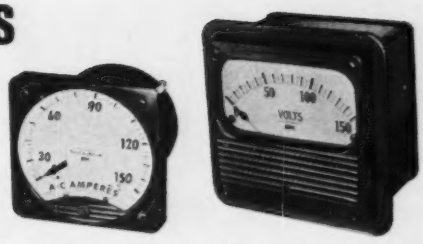
As a result of the outstanding performance records and customer preference established by thousands of Westinghouse TBS* instruments in all types of applications during the past year, this revolutionary new instrument design has now been extended to the full line of our switchboard instruments. These include the full-view 4½" circular scale, and 6" rectangular 100° scale designs. This remarkable development, introduced by Westinghouse in 1958, enables Westinghouse instruments to withstand extreme vibration and shock that adversely affect any other instrument. Users have found, too, that TBS offers *complete freedom from replacement of pivots, bearings and springs* . . . a significant saving in instrument maintenance costs. All types also meet or exceed ASA Specification C39.1 for switchboard instruments.

Exhaustive tests, conducted over a period of more than three years, included the most severe shock and vibration conditions that could be imagined for instruments. Field performance has more than justified our expectations. Application data derived during this period will help us continue to lead the industry in developing more accurate and reliable instrumentation for you.

Elimination of the conventional pivots and bearings provides an extremely rugged unit . . . eliminates friction . . . provides higher sensitivity . . . and results in almost infallible repeatability. For example, the Type KX-241, 250° full-view instruments



switchboard instruments



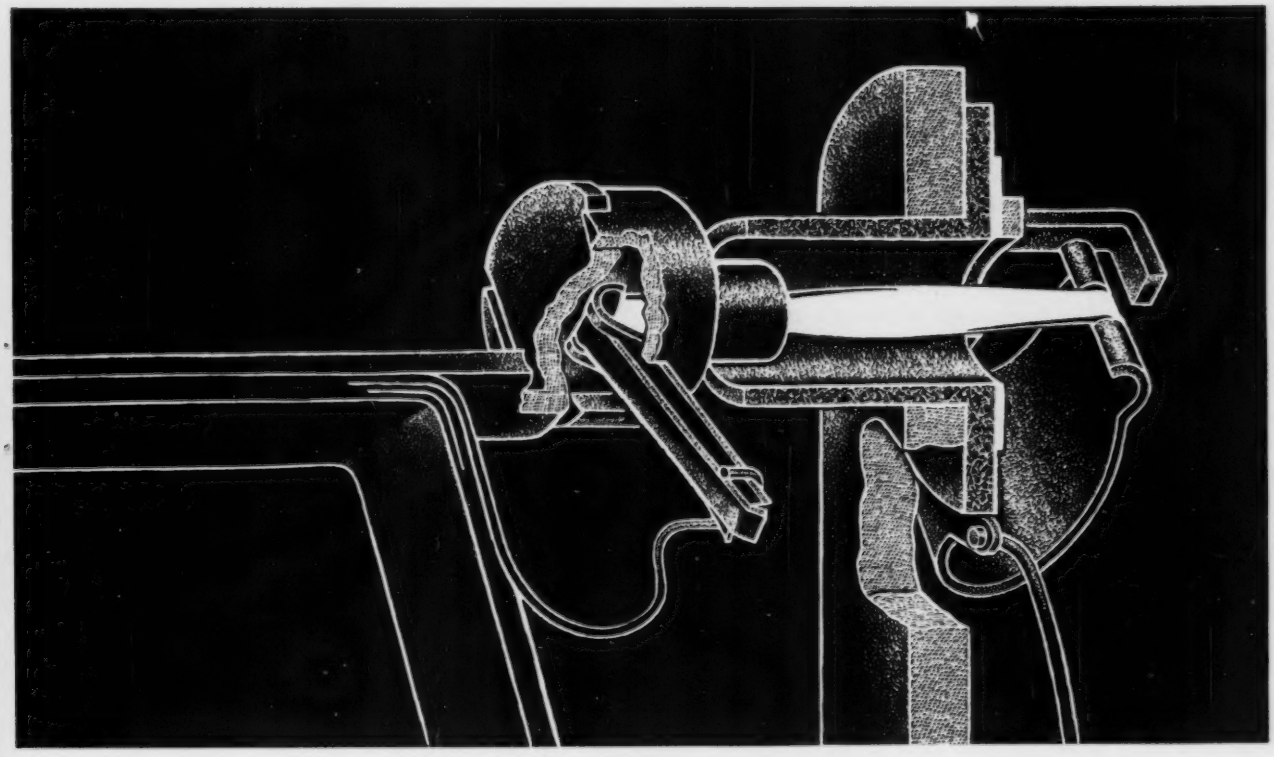
have full-scale deflection as low as 50 microamperes. Even higher sensitivities are available in the Type KX-251, 100° scale designs. These sensitive instruments will continuously withstand overloads up to 150 times full-scale deflection.

The Westinghouse TBS switchboard instrument line includes: both a-c and d-c ammeters, milliammeters, voltmeters; d-c microammeters; frequency meters; temperature indicators and ground detectors; a-c wattmeters and varmeters with Hall generator watt transducers.

Call your Westinghouse representative for complete details of the remarkably rugged TBS line. Or, write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

*Westinghouse "Taut Band Suspension"—A tough metal band about one-tenth the thickness of a human hair is the heart of the amazing suspension system developed by Westinghouse instrument engineers. All Westinghouse instruments shipped after June 30, 1960, using Taut Band Suspension will bear the trade-mark *tbs* on the dial face. J-40532

YOU CAN BE SURE...IF IT'S Westinghouse



NEW SCAM®

MAGNA-PLAC

NAMEPLATE

Your systems' sentry, Scam De-Line annunciators, now offers a new MAGNA-PLAC nameplate which provides a full 10½" of engraving area—70% more than conventional nameplates.

MAGNA-PLAC gives engineers increased area to more accurately describe condition variations or to employ larger characters for greater visibility. MAGNA-PLAC is interchangeable with standard Scam nameplates and optionally available on De-Line units *without extra charge*.

Other De-Line features include side by side or stack mounting for practical, *economical* system expansion; a single plug-in relay for both normally open *or* normally closed contacts; and sequence options *after* installation.

Yes, continuous product improvements such as MAGNA-PLAC, flexible application, ruggedness and reliability are what make De-Line the engineer's annunciator.

Complete Monitoring Systems for Industry

SCAM® INSTRUMENT CORP.

Dept. C, 1811 W. Irving Park Rd., Chicago 13, Ill.

Representatives in Principal Cities

WRITE FOR MORE INFORMATION on De-Line MAGNA-PLAC. Just sign and attach coupon to company letterhead.

NAME _____

New & Improved Products

(*Continued from page 30A*)

Process Computer . . .

Designed to combine instrumentation from primary elements to final control, the *690* industrial processing computer features parallel operation and a high computation speed. The system features an unusually large memory with a special instruction vocabulary. A core memory provides access capacities of 1,024, 2,048, and 4,096 words. Random access permits a word extraction in 20 microseconds. A drum memory, normally used for program storage, is available in capacities of 4,096 and 8,192 words, with access time of 17 milliseconds. Applications will range from electric power generation control to petroleum refining and steel mill operations. *Minneapolis-Honeywell Regulator Co., Wellesley Hills, Mass.*

Brushless D-C Motor . . .

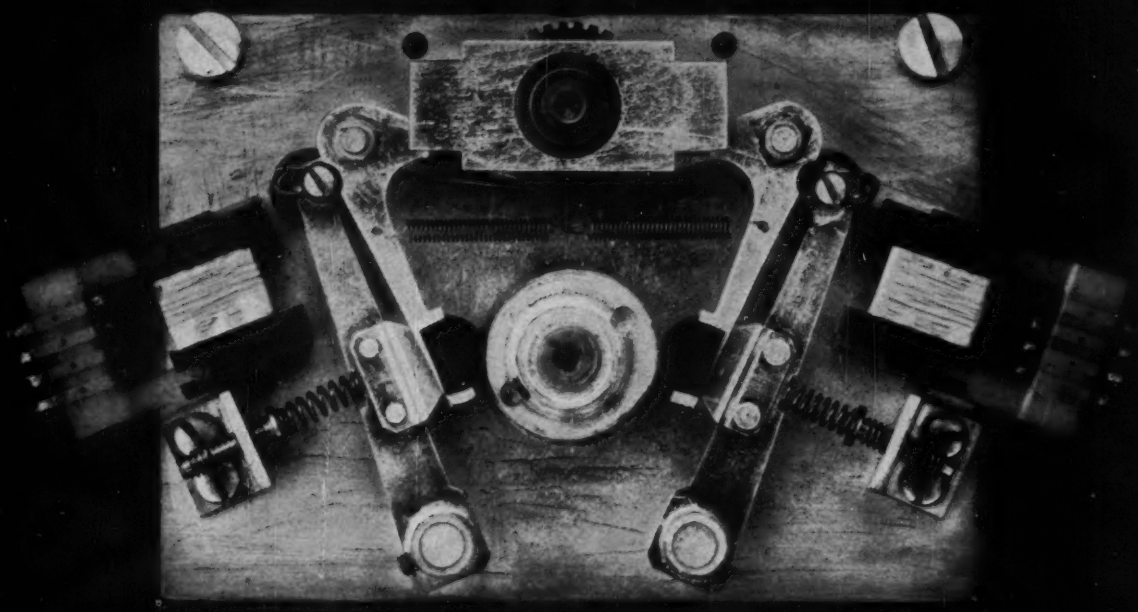
Brushes, brush racks, springs, slip-rings, and commutators have all been eliminated from this newly developed d-c motor. The resulting design not only allows a drastic decrease in motor size, but also eliminates radio noise and those environmental problems usually encountered in operating d-c motors in explosive gases and fuels, or in outer space. Speeds can be varied through an infinite range, with smaller units operating up to 250,000 rpm. Centrifuges, mixers, vacuum cleaners, and other machines and appliances may eventually benefit from this development. *Yuba Consolidated Industries, Inc., 1275 California Ave., Palo Alto, Calif.*

Pad-Mounted Transformer . . .

A new transformer, designed especially for commercial suburban areas with heavy low-voltage load concentration, is now available in 3-phase sizes, 225 through 1,500 kva with high-voltage, 2,400 through 13,800 (no taps), and with a low voltage of 208Y/120 or 480Y/277. Low in cost and versatile in application, these pad-mounted transformers are suitable for use in shopping centers, hotels, drive-in theaters, schools, motels, and other commercial areas. All unnecessary gauges and accessories have been eliminated giving the transformer modern uncluttered exterior. *Allis-Chalmers Manufacturing Co., Milwaukee 1, Wisc.*

(*Continued on page 54A*)

Opportunities in Systems Development



Harnessing a new principle of incremental drive

Here is a new way to convert high-speed shaft motion into precise increments, stepping forward, backward or oscillating alternately. It was developed from scratch by IBM engineers.

This truly clutchable incremental stepper provides precise control of acceleration, runs at high speed, and has great accuracy.

The Method of Attack

IBM engineers tackled the problem of high-speed, start-and-stop motion on a theoretical basis. They analyzed the loads and accelerations involved, and decided what masses and forces would be practicable. The stepper they developed is not only more versatile and efficient than alternate methods but also gives greater life expectancy, requires no elaborate oil bath, and is easier to package into a machine assembly.

Whether it's a problem in mechanics, electronics or physical science, IBM engineers are encouraged to attack problems from fresh viewpoints. Depending on your field, you might be interested in the advances IBM people are making in magnetics, microwaves, semiconductors and inertial guidance. In every area of research and development, you will find IBM receptive to the individual who wants to make significant contributions.

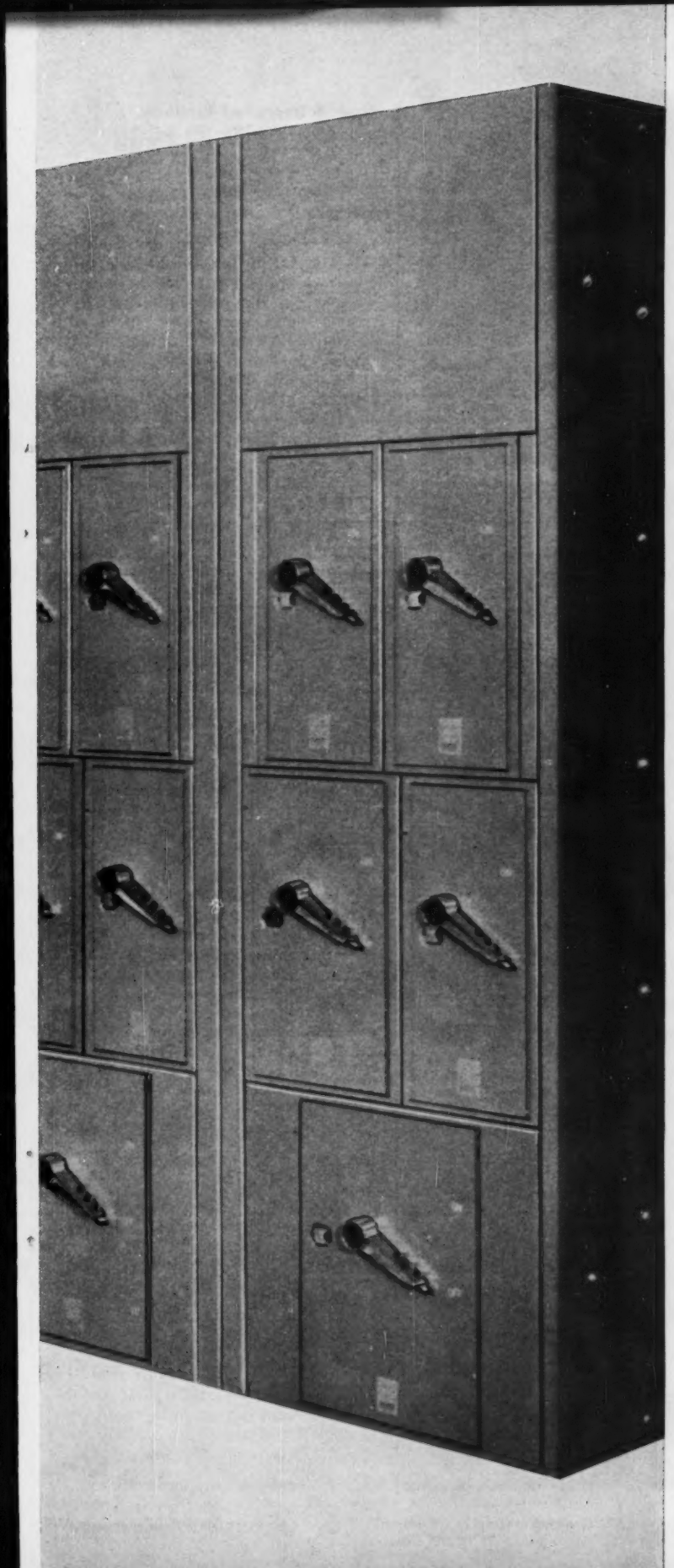
How to Start an IBM Career

Right now, there are several key openings in IBM's expanding research and development staff. If you have a degree in engineering, mathematics or one of the sciences—plus experience in your field, write, briefly describing your qualifications, to:

Manager of Technical Employment
IBM Corporation, Dept. 550W
590 Madison Avenue, New York 22, N. Y.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION



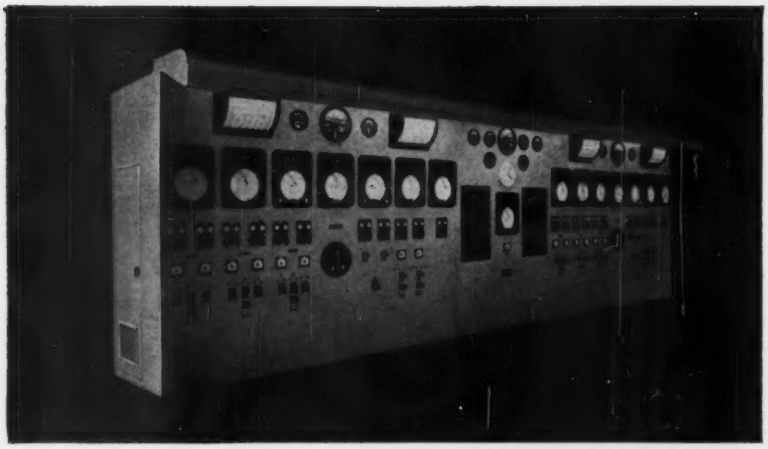
why can't everybody build switchboards like this?

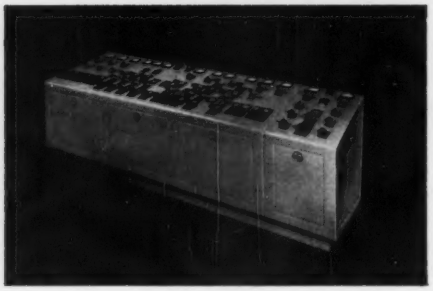
The answer is simple: only Federal Pacific has the Rotary Handle QMQB fusible switch units with visible blades... with the high-current capacity of a circuit breaker... with the 200,000 ampere interrupting capacity of fuses. Some manufacturers still use welded angle frames of 16 or 14 gauge steel plates. Federal Pacific utilizes bolted channel construction of 11 gauge steel for maximum strength and rigidity. What's more, Federal Pacific switchboards are designed on the modular principle: when you need to control more power, you can add units or entire sections — quickly and easily. Look again at the switchboard shown! It looks as new on the outside as it is on the inside—thanks to the Raymond Loewy design—exclusive with Federal Pacific. And if you think all this costs more, you're in for a pleasant experience when you contact your Federal Pacific representative. Write for Bulletin 2100, Dept. FP-7, Federal Pacific Electric Co., Newark 1, N. J.

FEDERAL PACIFIC ELECTRIC COMPANY

FPE

growth through creative energy





Sheet Metal and Alloy Components, Weldments and Plate Work, Custom Fabricated

Electrical Enclosures

- Serving the nation's leading manufacturers for over 50 years
- Complete facilities to ½" thicknesses in sheet, plate and light structurals
- Specialists in stainless, aluminum, monel and other alloys
- 170,000 sq. ft. plant with crane capacity up to 25 tons

Write for your copy of the K&B 40-page Fabrication Catalog or send your prints for prompt quotation.

The Kirk & Blum Manufacturing Co.
3204 Forrer St., Cincinnati 9, Ohio

Custom Fabricated by

KIRK & BLUM

New & Improved Products

(*Continued from page 50A*)

TV Microwave Relay . . .

Designed to provide ten times the rf power output of previous models, this new *MV-30* system utilizes a full 1-watt klystron to generate the microwave carrier and provide a 10-db signal strength gain. This increased signal-to-noise ratio insures better quality television pictures. The receiver features a long-life if strip with built-in phase equalization for minimum distortion. *Motorola Inc., 4501 W. Augusta Blvd., Chicago 51, Ill.*

Push Key Storage . . .

A savings of 70% in floor space and 32% in man-hours can be realized with this latest storage and materials handling device. Employing a dual command with a memory circuit, the operator can set the device to deliver one load and then pick up a different load in another location in one selective loading cycle. Pallet loads up to 1,000 pounds can be placed or retrieved in 768 openings for random storage by an electrically operated traveling crane. *The Triax Co., 11955 Shaker Blvd., Cleveland 20, Ohio.*

Miniature Motor . . .

Less than 1 cubic inch in size and weighing only 4 ounces, this miniature ⅓-hp hydraulic servo motor is barely 1/100 as large as a conventional motor of equal power. Designed for controlling missile antennas as they track moving targets, the motor can also be used to control missiles, aircraft, and marine vehicles. Full power is developed at 6,000 rpm and displacement is 0.02 cubic inches per revolution. *Bendix-Hamilton Div., Hamilton, Ohio.*

Connectors . . .

Fabricated from high-strength *6061-T6* aluminum alloy, these connectors and lugs are electro-tin plated to assure high tensile yield strength, resistance to corrosion, and high electrical conductivity. Cited as having 50% more strength and conductivity than common aluminum die cast alloys, the line is designed for single and double cables up to 600 MCM, box style lugs up to 600 MCM, and switch gear lugs with two mounting holes up to 1,590 MCM. *Ilsco Corp., 4730 Madison Rd., Cincinnati 27, Ohio.*

(*Continued on page 56A*)

imagine!... 7,500,000*

Think of it—*the highest magnetic power ever achieved, in virtually any size and shape*—through the use of *commercially produced* ALNICUS 75®... an entirely new and exclusive development of U.S. MAGNET & ALLOY CORPORATION.

This revolutionary advance in the development of a *high energy level permanent magnet material* is in marked contrast to the time when we were boys experimenting with the magic of magnetism—an era when industry knew little of the many possible uses of the magnet.

Today—an age of space and automation—the permanent magnet has become a vital component used in one form or another in all industries. ALNICUS 75®, with its nominal energy product of 7,500,000 gauss-oersteds, broadens the scope of magnet use. For example—with commercially produced ALNICUS 75® it is now possible to have increased magnetic energy with no increase in unit size or weight... or, retain the same magnetic energy with less magnet weight. More important... **ALNICUS 75® can be cast into virtually any size or shape**... because it maintains its high magnetic power in all configurations!

ALNICUS 75® is of signal importance to the design and development groups in the fields devoted to the manufacture of ■ Loudspeakers ■ Generators ■ Motors ■ Magnetrons ■ Galvanometers ■ Magnetos ■ Tachometers ■ Relays ■ Separators ■ Magnetic Chucks ■ Oil Filters ■ Holding Magnets ■ Recorders ■ Radar Equipment ■ Meters ■ Computers ■ Electronic Equipment

For complete information about ALNICUS 75® and its advantages for the Design and Development group in your firm, write for Brochure 10-E. Please address general inquiries to Dept. 10-E. *gauss-oersteds

MAGNETIC MATERIALS DIVISION
U.S. MAGNET & ALLOY CORP., 266 Glenwood Avenue, Bloomfield, N.J.

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By MIHAJLO D. MESAROVIC, *Case Institute of Technology.* A Technology Press Research Monograph, M.I.T. 1960. Approx. 128 pages. Prob $3.50

FREQUENCY-POWER FORMULAS
By PAUL PENFIELD, JR., *M.I.T.* A Technology Press Research Monograph, M.I.T. 1960. Approx. 256 pages. Prob. $4.50

ELECTRONIC PROCESSES IN SOLIDS
By P. R. AIGRAIN, *Univ. of Paris,* R. J. COELHO, *M.I.T., and* G. ASCARELLI, *Univ. of Illinois.* A Technology Press Research Monograph, M.I.T. 1960. 67 pages. $4.00

DYNAMIC BEHAVIOR OF THERMOELECTRIC DEVICES
By PAUL E. GRAY, *M.I.T.* A Technology Press Research Monograph, M.I.T. 1960. 136 pages. $3.50

PRINCIPLES OF SEMICONDUCTOR DEVICE OPERATION
By A. K. JONSCHER, *General Electric Co., England.* 1960. $5.75

PRINCIPLES OF ILLUMINATION
By H. COTTON, *University of Nottingham.* 1960. 526 pages. In Press

THE THEORY AND DESIGN OF INDUCTANCE COILS
By V. G. WELSBY, *Univ. of Birmingham.* 1960. 232 pages. In Press

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New & Improved Products

(Continued from page 54A)

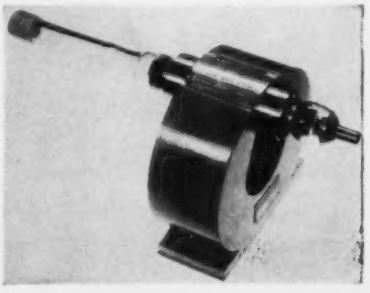
Palm-Operated Switch . . .

Developed for stamping machines, this new palm-operated press-button travels only ¼ inch, has a 7½-inch

push-button surface, and can be mounted in the machine cavity or in its own oil-tight enclosure. The standard unit is equipped with a nontelegraphing SPDT snap switch, although two switches for DPDT action are also available. A key lock is provided for by-passing the button when desired. *Square D Co., Dept. SA, 4041 N. Richards St., Milwaukee 12, Wis.*

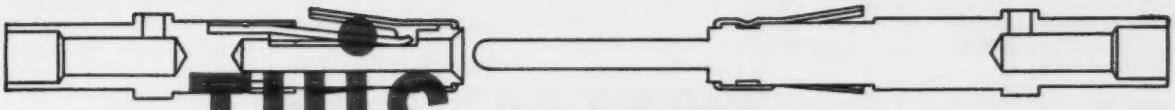
Ion Vacuum Pump . . .

These ultra-high vacuum pumps that are free from moving parts, refrigerants, traps, oils, and heating elements, will provide 50,000 hours of cleaner, drier, trouble-free operation. The model illustrated here pumps at the rate of 6 liters per second, and is



only one-fourth the size of a conventional unit of similar capacity. It can achieve pressures of less than 10^{-9} mm Hg in either metal or glass vacuum systems, and can be used concurrently as a vacuum gauge. *Hughes Aircraft Co., Vacuum Tube Products Div., 2020 Short St., Oceanside, Calif.*

IN RACK AND PANEL CONNECTORS



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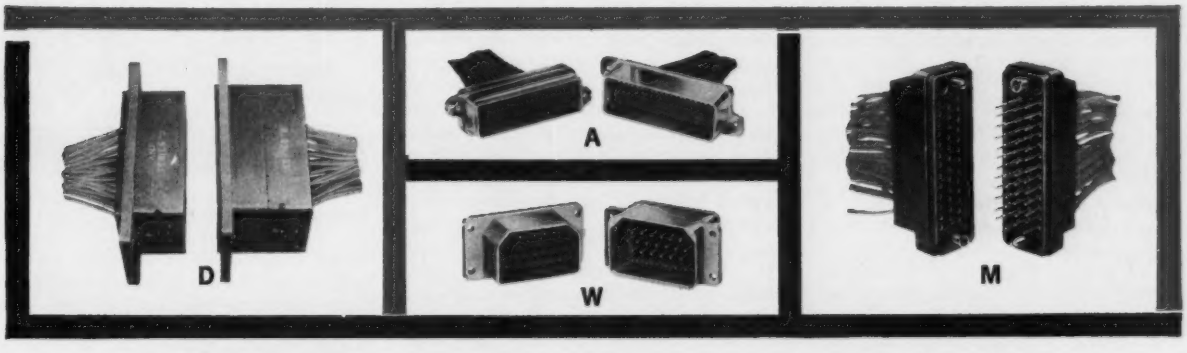
Right here in the socket contact lies the heart of the **AMPin-cert Connector** line: the AMP cantilever spring. Seated in the slot of the socket to meet the pin shaft, it is your key to top connector reliability.

It provides you with positive wiping action . . . consistently sound electrical contact . . . firm pin grip . . . and stable resistance—yet has an extremely low, uniform insertion and withdrawal force. And, regardless of the metal plating you choose or the thickness you require, all pins and sockets are provided with an underplating of nickel to give long life reliability in all critical applications.

Add to this cantilever construction, many other plus features including AMP's industry proven solderless crimping technique to help you design and manufacture products of the highest reliability and lowest cost.

Take your pick: **AMPin-cert Connectors** in Series D, M and W as well as environmentally sealed or unsealed Series A—all tough enough to soak up heavy punishment while providing the dry circuit sensitivity you need for your most critical applications.



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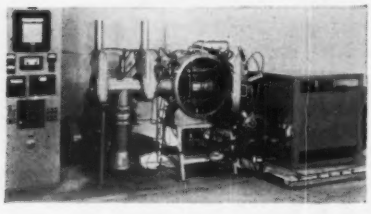
Industrial Notes...

NRC Equipment Corp. Newton, Mass. . .

A tantalum element vacuum resistance furnace that operates in the 4,200 F range and is said to be the largest unit yet constructed for brazing, sintering, and heat treating of refractory alloys, has recently been delivered to The Martin Company, Baltimore, Md. It will be used by Martin for manufacturing research and production of missile parts, including brazing



of high-temperature honeycomb sections. Developed by NRC Equipment Corporation, a subsidiary of National Research Corporation, for the nuclear, electronics, aircraft, and missile industries, the new furnace utilizes a unique resistance element system that allows for expansion of the tantalum heating strips at elevated temperatures. This system consists of a series of serpentine-like heating elements, corrugated for additional strength and supported by shielded, water-cooled copper posts. Thus designed and mounted, the elements are protected against distortion and, hence, premature burn-out. They are also designed for low-voltage operation to prevent arcing. Total power input to the furnace is divided equally on all six sides to insure uniform temperatures throughout the hot zone. Saturable core reactors control the voltages to each zone to prevent variations due to supply voltage.

Packard Bell Electronics Corp. Newbury Park, Calif. . .

A new 53,000-square-foot building in the company's 100-acre Electronics Park, was opened by Packard Bell Electronics Corp. in a dedication ceremony presided over by a robot master of ceremonies. Packard Bell's new general-purpose computer performed the function with microsecond speed in conjunction with an automatic typewriter and closed-circuit television. Included in the new facility is a permanent Museum of Electronics History. The project currently houses elements of the Technical Products Division which designs, develops, and manufactures advanced electronics instruments and systems for industry and defense.

Wall Manufacturing Co. Grove City, Pa. . .

To facilitate free engineering service, and to expedite deliveries, Wall Manufacturing Company, manufacturers of electric soldering pencils, irons and guns, are appointing warehouse distributors throughout the country. The first group of warehouse distributors, appointed in the New York-New Jersey area, includes Arrow Electronics, Bruno-New York, and Electronics Center, all of New York City, and Federated Purchaser, of New Jersey. Additional warehousing distributors will be appointed in other areas on the basis of their facilities, their service records to accounts, and their proximity to major manufacturing centers. Additional field engineers are being added throughout the United States and Canada. Wall is planning technical training programs for distributor salesmen.

Line Material Industries Milwaukee, Wis. . .

A high-voltage research laboratory has been constructed by Line Material Industries (L-M). The new laboratory is the latest step in the company's expansion of its 134-acre Thomas A. Edison research and engineering center at Franksville, Wis. Designed to meet future industry needs, the laboratory has a surge generator and 60-cycle equipment having three times greater capacity than the company's South Milwaukee facilities. The new laboratory does not replace existing facilities, but supplements their test programs. Power frequency apparatus consists of two transformers capable of testing equipment up to 700,000 volts. Addition of a third transformer will boost the capacity of the cascaded combination to 1,050,000 volts. Wet and dry 60-cycle flashover tests, puncture tests on bushings and insulators, and radio influence studies can be conducted. Future plans for expanding L-M's high-voltage laboratory call for the addition of a low-voltage test bay with an observation balcony. The plant hopes eventually to move its entire engineering and research operations to the Franksville site.

Polarad Electronics Long Island City, N.Y. . .

Polarad Electronics Corporation has established Scientific Instruments Division, its first major diversification out of the field of microwave test equipment. The division will be responsible for the manufacture and marketing of scientific instruments specifically designed for the chemical, biological, and medical fields. Several new instruments already undergoing extensive government and laboratory testing include a digital pH meter that will provide for discreet digit readings, thereby eliminating the need for interpolation and possible operator error; chemical test equipment such as a titrator which is capable of performing all potentiometric and ampereometric titrations, and viscometers capable of measuring the molecular weights of polymers at lower shear rates than any instrument currently available. The division intends to inaugurate a sample testing service that will enable prospective users to submit samples for testing.

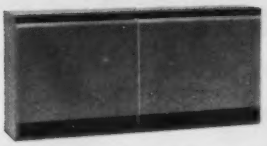
International Resistance Co. Philadelphia, Pa. . .

International Resistance Company has recently been awarded a $1 million contract to produce XLT high-

reliability resistors for the U.S. Air Force's Minuteman ICBM. The contract, awarded by Autonetics, a division of North American Aviation, Inc., associate prime contractor for the Minuteman's guidance and control system, follows the earlier award of a $1.7 million contract to develop and test a high-stability high-reliability fixed metal film resistor. Resistors are produced in the ultra-clean room pictured, in which such factors as dust, temperature, and humidity are carefully controlled.

(Continued on page 60A)

BENDIX G-20



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Just as the organization chart of any enterprise provides the framework for dynamic growth and adaptation, so "organization chart" design provides the framework for unparalleled expandability in the Bendix G-20 data processing system. This means that your G-20 can economically match, step by step, your expanding scientific or business computational workloads ... without sacrificing system balance. • Key to the organization chart efficiency of the Bendix G-20 is the ability of the Central Processor to "delegate" routine data handling tasks to control buffers, acting as "line supervisors." Thus freed, the Central Processor can make most efficient use of its high computation speed, its ability to schedule program priorities and direct accessory equipment assignments. • The ability to employ many control buffers gives new meaning to expandability in the Bendix G-20. Up to 70 input/output units can be directed by each of these "line supervisors." The Bendix G-20 has a complete line of accessory equipment including keyboard, paper tape, punched cards, high speed line printers, and 2 million word magnetic tape units. • Memory represents another dimension of G-20 expandability, ranging from 4,096 to 32,768 words. • Investigate the organization chart design of the Bendix G-20. See how it provides balanced, *practical* expandability ... at a cost that assures unequalled data processing performance per dollar invested. • ***For detailed literature write:***

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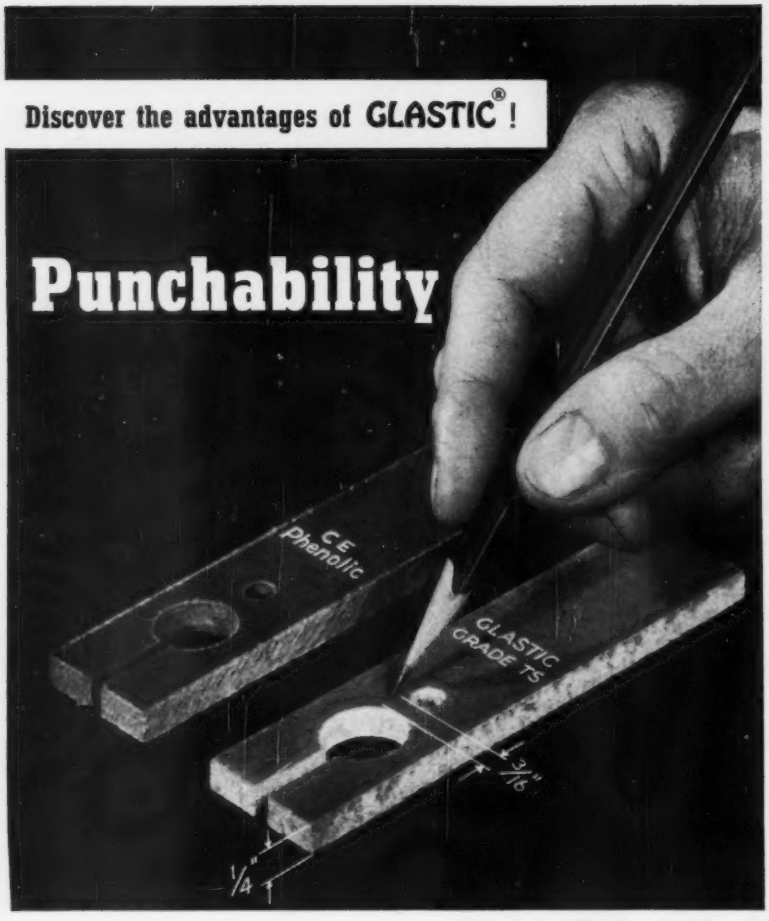

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Industrial Notes

(Continued from page 58A)

Flexible Tubing Corp. Guilford, Conn. . .

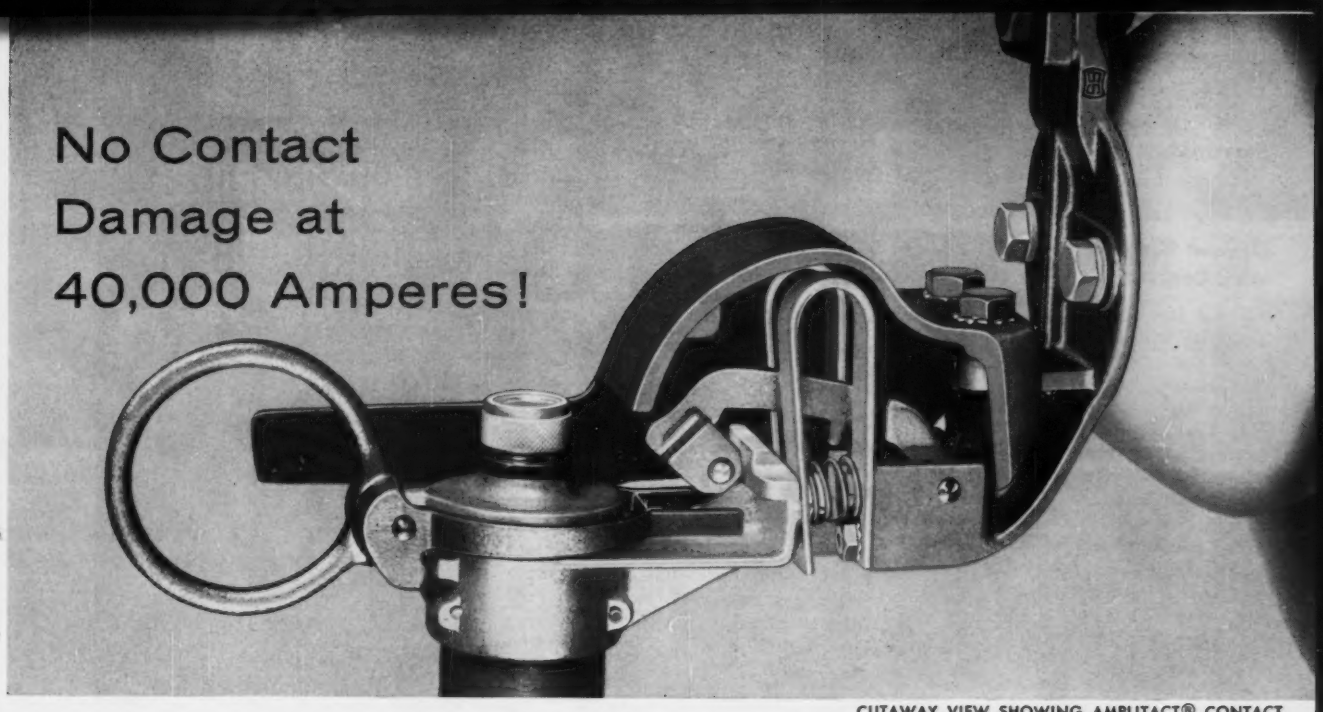
Lightweight, flexible tubing designed by the Flexible Tubing Corporation, was used by the Commonwealth Edison Company of Chicago, Ill., to

pump water from 27-foot-deep manholes before electrical work was done. Working with patented Spiratube, Flexible Tubing engineers added extra protection with a "scuff strip" and designed a close-pitch helix to provide additional rigidity. The result is a suction hose that will not collapse, that can be pulled in and out of the hole by one man, and that can be stored easily on overhead hooks inside the truck.

Ultrasonic Industries Inc. Albertson, N.Y. . .

Ultrasonic Industries Inc. has announced the formation of a Canadian subsidiary, Ultrasonic Industries (Canada) Ltd. (UI), at 1512 Eglinton Ave. West, Toronto, Ont. This is the first of several such companies contemplated by UI in the development of international markets for its diSONtegrator ultrasonic cleaning equipment and other ultrasonic devices. The first company exclusively devoted to ultrasonics to be incorporated in Canada, the branch will direct Canadian marketing, distribution, and service activities for the New York office. The new organization will act as sole sales agent co-ordinating the affairs of diSONtegrator distributors throughout the Dominion now serving the dental, optical, medical, jewelry, electronic, and precision instrument industries. Inventories of all diSONtegrator ultrasonic cleaners and SONitizer cleaning chemicals, as well as service and repair facilities, will be maintained at the Toronto warehouse under 24-hour service.

(Continued on page 62A)



CUTAWAY VIEW SHOWING AMPLITACT® CONTACT

SOUTHERN STATES' POWER FUSES EMPLOY AMPLITACT® CONTACTS TO PREVENT CONTACT DAMAGE

Now, for the first time, "switch-proved" Amplitact® contacts are used on Southern States power fuses. Repeated tests at current ratings up to 40,000 amperes show no contact damage.

Used successfully for many years on Southern States air switches, Amplitact® contacts are now used on the new BPA and HPA Power Fuses.

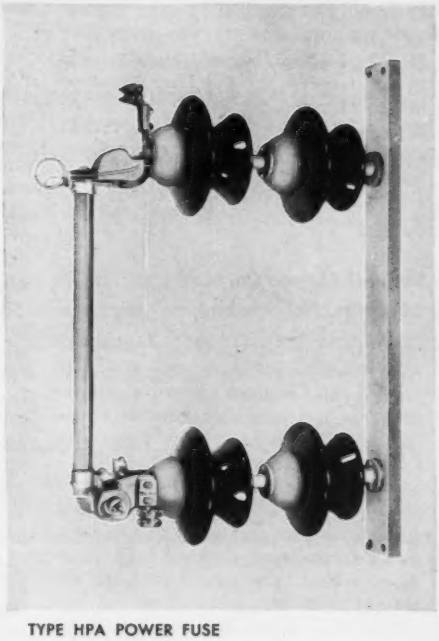
The Amplitact® harnesses electromagnetic forces generated on a high fault, increasing contact pressure when it is needed most.

While contact damage under extremely high fault currents has been more irksome than serious, the Amplitact® eliminates any possibility of damage.

These new power fuses have all of the outstanding advancements of the BP, MP, and HP power fuses introduced by Southern States in 1959—plus the reverse-loop contact. They have expendable cap fuse holders to provide dependable clearance of high or low current faults. Fuse holders are designed for easier handling and are equipped with a large operating eye. A stationary sleet shield gives better protection against icing and provides guidance when the fuse is slammed closed.

Low cost refusing in the field is accomplished with easy-to-use fuse kits.

Get your Southern States representative to give you full information about this important development in power fuses, or write direct for Bulletin 60 PF.



TYPE HPA POWER FUSE

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IN CANADA
Dominion Cutout Co., Ltd., Toronto

SOUTHERN STATES
EQUIPMENT CORP.
HAMPTON, GEORGIA

Industrial Notes

(Continued from page 60A)

General Radio Company West Concord, Mass. . .

An innovation in road exhibits, featuring the latest developments of six of the nation's leading instrument manufacturers, will be staged this fall at five key sites around metropolitan New York and Philadelphia. This new concept in traveling technical shows, which will be officially known as the "Electronic Instrument Manufacturers' Exhibit," will offer for the first time under one roof, an unusual operational array of both complementary laboratory and production-test instruments, with ranges of from d-c to 220 kms. The project will be under the sponsorship of FXR, Inc.; General Radio Company; Lambda Electronics Corp.; Panoramic Radio Products Co., Inc.; Sensitive Research Instrument Corp.; and Tektronix, Inc. All displays will be arranged to insure maximum exposure of exhibited items. Booths will be manned by engineer specialists from the participating companies, providing a unique opportunity to obtain first-hand information on calibration and measurement problems in practically all areas of electronics. The five touring-exhibit areas will be: Garden City, L. I., N. Y., Sagamore Room, Roosevelt Field Shopping Center, October 5-6; Norwalk, Conn., Treadway Inn, October 11; Poughkeepsie, N. Y., Nelson House, October 13; Cedar Grove, N. J., The Meadowbrook, October 17; and, in the Philadelphia vicinity, Moorestown, N. J., Cherry Hill Inn, October 19-20. Show hours for every date will be from 1:00 p.m. to 9:00 p.m.

Federal Electric Corp. Paramus, N.J. . .

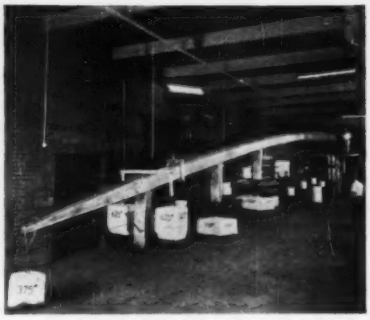
Two contracts totalling $503,847 have been awarded by the U.S. Air Force to the Federal Electric Corporation, the service corporation of International Telephone and Telegraph Corporation. One contract, for $201,530, is for installation and operational testing of the Time Division Data Link Subsystem for use with the SAGE (Semi-Automatic Ground Environment) system. The second contract, for $302,317, is for preparation of development schedules to determine whether wire telephone systems at various bases are adequate. The awards were made through the Directorate of Procurement and Production at the Rome Air Materials Area, Rome, N. Y.

Electronic Communications, Inc. St. Petersburg, Fla. . .

A $656,000 U.S. Air Force contract for the development of large, high-powered radar equipment has been received by the Research Division of Electronic Communications, Inc. The equipment, which is to be used for missile tracking, forms part of the Air Force anti-ICBM project.

Alrectic Jackson, Mich. . .

A tapered Alrectic octagonal pole, 85 feet long with a 2-foot base width, demonstrated the ability to withstand hurricane forces during recent simulated tests before 50 utility and consulting engineers. Static loads simulated wind loading up to a maximum of 140 mph, which is 12% greater than



National Electrical Manufacturers Association standards. Three severe wind-loading tests illustrated the high strength of the octagonal pole while supporting three 1.28-inch diameter aluminum cable steel reinforced conductors and a ⅜-inch high-strength static wire. These tests simulated winds of 110, 125, and 140 mph. The pole, designed for Louisiana Power and Light Company, is intended for use on a 110-kv transmission line through congested residential and business areas. Average span will be 600 feet. Fabricated and tested by the Alrectic Division of McGraw-Edison Company, Jackson, Mich., the pole will be distributed by Line Material Industries, Milwaukee, Wis. The octagonal pole, complete with three 7-foot crossarms, weighs 2,400 pounds, approximately 30% of the weight of an equivalent steel pole and 10% of the weight of an equivalent concrete pole. The aluminum Alrectic octagonal pole offers attractive appearance, high strength, light weight, corrosion resistance, reduced maintenance, and safety for utility personnel and the general public.

(Continued on page 64A)

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AiResearch cooling of airborne detection systems is accomplished by an extremely reliable, compact unit which is both an air-cooled cold plate and mounting structure for the detection system's transistorized power supply.

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The complete guide to modern materials handling. This unique Handbook explains the governing principles, today's most efficient methods and systems, and recommended equipment for moving material at least cost — whether in raw, in-process, or finished form.

Useful in all industrial situations. Handbook answers every basic question of work flow within and outside the plant. *Sponsored by The American Society of Mechanical Engineers and the American Material Handling Society. 991 illustrations, tables; 1,740 pp. 84 Contributing, Consulting Editors. Harold A. Bolz, Ed.; George E. Hagemann, Assoc. Ed. 1958.* $20

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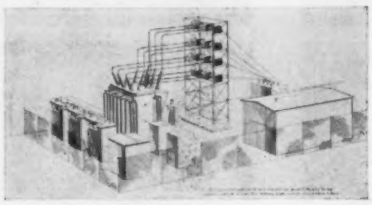
Industrial Notes

(*Continued from page 62A*)

Eitel-McCullough, Inc. San Carlos, Calif. . .

Eitel-McCullough, Inc. (Eimac), is now constructing an ultra-high-voltage power supply which will make possible the development and production of tubes fifteen times more powerful than



existing tubes. This ultra-high-voltage power supply will be located in the super-power tube facility now under construction near Eimac's corporate headquarters at San Carlos, Calif. The high-flexible power supply will be used to test electron-power tubes for many commercial applications, and to meet essential electron-tube requirements for space-age radar, communication, and linear accelerator systems. The power supply is expected to provide 282 kv at 12 amperes or 3 million watts of power. High-voltage power distribution transformers will be utilized throughout the supply to assure maximum reliability. These oil-filled transformers will weigh from 5 to 15 tons each and are capable of withstanding tremendous electrical overloads. The new power supply is scheduled for completion in early 1961.

RCA New York, N.Y. . .

A broad-scale leasing plan under which educational institutions, laboratories, and other users may rent scientific instruments has been announced by the Radio Corporation of America (RCA). The plan is expected to make available to an increased number of organizations, regardless of size, such RCA scientific aids as the electron microscope equipped with an ultra-magnifier, which can enlarge specimens more than 1 million times. The RCA lease plan calls for no down payment. Prorated credit for part of each month's rental may be applied toward outright purchase of the equipment during the 5-year lease tenure. At the end of the initial lease period, purchase may be arranged at a pre-determined fraction of the original equipment cost.

American Electric Power Service New York, N.Y. . .

A giant cooling tower rising 320 feet above the ground, the first of its kind to be used in the Western Hemisphere, will be built adjacent to Kentucky Power Company's new Big Sandy Plant near Louisa, Ky. The Marley-Mouchel cooling tower will be constructed by the Marley Company of Kansas City, Mo. Completion of the $39 million, 265,000-kw power plant is scheduled for late 1962. The tower will provide the vital and constant supply of cool water required by the power plant's condenser for steam-condensing purposes. It will be hyperbolic-shaped and erected on a stilt-like structure. Long popular in foreign countries, this design has never before been used in North or South America. Its selection came after a 2-year study by engineers of the American Electric Power Service Corporation, which designed the power plant.

Thompson Ramo Wooldridge Canoga Park, Calif. . .

Thompson Ramo Wooldridge Inc. (TRW) has announced the formation of an Educational Electronics Division through consolidation of the educational sales groups of TRW's subsidiary, Magnetic Recording Industries, and the company's Dage Television Division. Located in New York City, the division will be responsible for marketing a wide range of commercial electronics products for use in schools. These products include closed-circuit television systems, language laboratories, teaching machines, special disc tape and tape magazine recording systems, tape magazines, tape duplicators, electronic classrooms, and other educational services. The move is intended to supplement the normal distribution of consumer and industrial electronic products.

Hysol Corp. Olean, N.Y. . .

Hysol Corporation, pioneer-manufacturer of epoxy resin compounds in the United States, is currently expanding its manufacturing and laboratory work areas by approximately one third. The total space involved for 1960 more than doubles the amount of expansion undertaken during any previous fiscal year. The new construction is expected to provide for both a business increase and a complete reorganization of manufacturing flow procedures projected for 1960.

(*Continued on page 67A*)

Why 8 out of 10 engineers read the advertising pages of Electrical Engineering

Month after month, the editors of Electrical Engineering ask representative groups of readers to say what sections of the magazine they read and find most helpful in their work.

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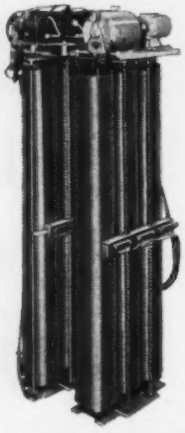
- AC or dc output.
- Any volt-ampere curve characteristic—constant current, constant voltage, or reactive to any degree you want.

LINE COMPENSATION VOLTAGE REGULATOR for radar station accepts 3-phase, 208v ±10%, delivers 3-phase 208v ±1% at 300 amp., with non-distorted sine wave at all settings. Rated at 108 kw, 100% duty cycle, convection cooled.

ELECTROLYTIC CAPACITOR FORMING power supply provides continuously-variable dc output from 0 to 415 volts, 300 amperes. Input is 230/460 v 3 phase. Other units available with 0-250 v output. Many of these GLENN PACIFIC units are used by leading capacitor manufacturers.



VARIABLE VOLTAGE transformer used in laboratory power supply delivers 0 to 460 v ac at 200 amperes; operates from 3 phase 208/230 v input.

WHAT'S YOUR PROBLEM? Need a dc source for motor drive and speed control—for powering laboratory or production line dc magnets, instruments, test stands—for electroplating, electrolytic refining, etching, de-tinning? You'll be hours and dollars ahead to contact GLENN PACIFIC; please address Dept. 135.

GLENN PACIFIC CORPORATION
INDUSTRIAL POWER SUPPLIES
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221 Dukes Road Rahway, New Jersey

MID-WESTERN OFFICE
640 South York Elmhurst, Illinois

4

Power Supply for Resistance Welding Machines
(April 1952)

AIEE Special Publication S-45 is a report of the AIEE Subcommittee on Power Supply for Resistance Welding Machines. Recognizing that the installation and use of any resistance welding process vitally concerns not only the industrialist requiring the process but also the welding machine manufacturer and the utility supplying the electric power as well, the committee has in this report brought together much pertinent data from the knowledge, literature, and experience in all these fields.

This publication supersedes the AIEE reports of the same title presented in 1940-1. The new work is required by developments in welding machines, new processes, better analysis of certain phenomena (such as measurement of instantaneous loads, and interference between welders), and a clearer understanding of the whole problem of power supply for resistance welders.

This report is not intended to be a complete solution of all welding problems, but should direct attention to the special electrical features involved so that a full analysis developed for a welding project can be readily understood and utilized by manager, master mechanic, and electrical engineer.

Copies are available for the price of $1.00 (no discounts permitted). Address:

Order Department
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y.

Industrial Notes

(*Continued from page 64A*)

Electronic Instruments Ltd. Richmond, Surrey, England . . .

A Titromatic analyzer, designed and manufactured by Electronic Instruments Ltd., was recently installed by Messrs. Schweppes Ltd. in their Hendon, England bottling plant. The apparatus automatically and continuously monitors the final stages of processing by taking periodic samples of tonic water from the production line and automatically titrating them

to a preset end point. In addition, it provides a continuous graphic record of the tonic water stream and immediately warns of changes in concentration—all without staff assistance. The Titromatic analyzer consists of two cabinets hermetically sealed against humidity and fumes. One cabinet houses the chemical glassware including the sampling and titrating apparatus, and the other contains the electronic measuring recording and controlling equipment. Adaptable for both single and double end point titrations, the analyzer is also used for controlling spin bath concentrations in the manufacture of synthetic fibers, and for other industrial applications requiring frequent titrations to a definite end point.

Bill Jack Scientific Instrument Co. Solana Beach, Calif. . .

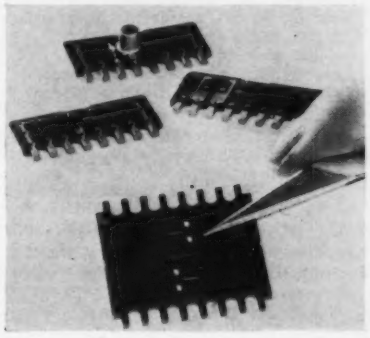
An expanded sales program has been announced by Bill Jack Scientific Instrument Co. The following new representatives were named: ARCO Engineering Co., District of Columbia; Joseph P. St. Clair, Alabama, Florida, and Georgia; L. J. Sculley & Associates, Dayton, Cincinnati, and Columbus, Ohio; and Donovan A. Dutton Co., Arizona, New Mexico, Utah, Colorado, and Idaho. The C & H Supply Co. continues as representative in Seattle, Wash. and Wichita, Kans., and Key Electronics, Inc., in the Los Angeles, Calif., area. All representatives also represent Digitac, Inc., counter subsidiary of Bill Jack Scientific Instrument Co.

Lockheed Aircraft Corp. New York, N.Y. . .

A major corporate office has been established in Boston, Mass., by Lockheed Aircraft Corporation. The office will serve as a key point of co-ordination for electronics activities of all Lockheed divisions and subsidiaries. Permanent offices will be located along Boston's "space highway" where 50 companies currently have research centers or manufacturing plants.

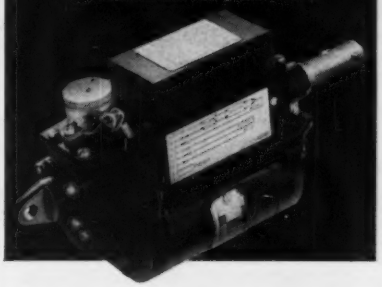
CBS Electronics Danvers, Mass. . .

Tiny wafers used to provide flexibility of circuit design, are shaped by a unique photographic process. Suitable for analog circuitry, the wafers are being used by CBS Electronics in its microelectronics program. Substrate for the firm's Universal Microdecks is a photosensitive glass-turned-ceramic, produced by Corning Glass Works. The Fotoceram wafers can be made in intricate detail without dies or drills. The pattern of the wafers is implanted in photosensitive glass, and the image is then etched away by acid to the precise shape and dimensions required. Heat treatment converts the special glass into a rugged ceramic material



that takes metallizing extremely well. The design of the wafers can be changed swiftly and easily simply by changing the photographic negative used to implant the pattern in the glass. Initial uses have been in computers and in equipment for aircraft and missiles.

COMPACT AiResearch 60 cycle Actuators *for ground use . . .*



Inexpensive, lightweight 60 cycle motor driven actuators with integral magnetic brakes* are now being manufactured by AiResearch for ground radar, ground support and shipboard use.

Unequalled in 60 cycle performance, these extremely compact, lightweight actuators range from fractional hp motor size up to any desired hp in single phase, two phase and three phase design for a wide variety of applications.

The above-pictured actuator is used in a ground radar system. It is driven by a single phase 60 cycle ac fractional hp electric motor and can be furnished with a feedback potentiometer for use in servo applications. The entire unit weighs only 2½ lb. and is rated at 200 lb. operating load.

OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

A C and D C Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.

* *patented 60 cycle operated magnetic brake*

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

Trade Literature . . .

Adhesive Properties Chart . . .

An adhesives properties chart contains the latest information on epoxy adhesives, their application, cure times, and physical properties. On the reverse side is such information as test methods, application suggestions, and availability. Ready reference for adhesive and paste applications will eliminate guesswork from material selection. *Furane Plastics Inc., 4516 Brazil St., Los Angeles 39, Calif.*

Amateur and Hi-Fi Catalog . . .

A 154-page buyer's guide to components and systems gives full coverage to the high-fidelity, stereo, and ham fields. The 1960-61 "Hi-Fi, Stereo and Amateur Radio Catalog" is available from *Arrow Electronics, Inc., 65 Cortlandt St., New York 7, N. Y.*

Lightning Arrester Bulletin . . .

A 4-page 2-color brochure describes and illustrates a newly designed crystal valve lightning arrester for the protection of power circuits of any kva capacity. Text, photographs, drawings, and charts explain the new arrester's exclusive "Crystallite" valve element, its gap structure, shorter length, new body contour, and its separator. Specific details for reference and ordering guidance include pricing information, approximate dimensions, features, characteristics, and leakage distance. *H. K. Porter Co., Inc., Delta-Star Electric Div., Chicago, Ill.*

Equipment Handbook 1-Year Subscription . . .

A special introductory offer features a free 1-year subscription to this multicolored, pocket-sized periodical. The handbooks feature detailed descriptions of new inventions, unique tools, and other devices of interest to executives. The periodicals also contain illustrations and descriptions of a wide variety of office and factory furniture and equipment. *General Industrial Co., 1794A Montrose Ave., Chicago 13, Ill.*

"Electronic Welding" . . .

The first issue of a new 8-page magazine, *Electronic Welding*, is now available. Issued quarterly, the publication will provide the electrical, electronic, and metalworking industries with authoritative, up-to-date information on precision metal-joining applications, such as assembly of electronic packaging, fine wire leads, thin and hard foils and screens, and miniature circuit modules. Notes on welding technology, new materials, and new developments in welding equipment will be among the regular features. *Don A. Drake, Editor, Weldmatic Division Unitek Corp., 950 Royal Oaks Dr., Monrovia, Calif.*

Solenoid Selector Chart . . .

A slide chart that assures selection of the correct "double T" solenoid for any given commercial or industrial application has a basic setting of desired length of solenoid stroke, calibrated from 0 to 1⅜ inches. The "O" setting indicates maximum quiet pull in seated position. Once length of stroke is set, pull in pounds and current draws in amperes can be read for various voltages in each constant and intermittent duty solenoid. The solenoid is then selected which best meets the pull requirements of the application. Instructions for use are included. *Mr. Phil Bain, Industrial and Commercial Controls Dept., Controls Company of America, 9555 Soreng Ave., Schiller Park, Ill.*

"Designing for Stability" . . .

This 2-part technical article was written to assist design engineers in the use of electrically controllable inductors in applications in which the effects of temperature change and hysteresis must be minimized. Part 1 of this article describes the effects of hysteresis and temperature changes and various open-loop methods for minimizing these effects. The principles and general considerations of closed-loop bellweather stabilization are also discussed. Part 2 deals with specific closed-loop and bellweather stabilization circuits. Request Inductor Notes No. 6 and No. 7 from *Trak Electronics Co., 49 Danbury Rd., Wilton, Conn.*

Electrical Operator Booklet . . .

A new booklet entitled "Westinghouse Electrical Operators" tells how to apply electrical operators for the remote control of circuit breakers. The 4-page publication includes a listing of electrical operator dimensions and a schematic diagram for installation. Request booklet B-7534 from *Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.*

Phosphor Bronze Handbook . . .

An 18-page technical handbook on phosphor bronze has been up-dated and reprinted from the original catalog published in 1959. In addition to a detailed explanation of continuous casting, the handbook includes information on phosphor bronze wire, bars, rods, strip, sheets, circles, and special shapes. Flexograin, a special fine-grain phospor bronze is discussed in detail. Complete specifications on six of the phosphor bronze alloys are also given in an easy-to-read format. *Publications Section, Riverside-Alloy Metal Div., H. K. Porter Co., Inc., Riverside, N.J.*

Gold Electroplate . . .

Latest techniques for controlling and measuring thickness and hardness of precious metal electroplates, with particular emphasis on gold, are discussed in an original technical paper "Thickness and Hardness Measurements on Gold Deposits," by Mrs. Grace Wilson, Laboratory Technician, Sel-Rex Corporation. Precise engineering applications for precious metal electroplates in industry are reviewed, and the importance of close control of the thickness and hardness of such coatings is discussed. The 3-page illustrated article points out the necessity of understanding in depth the techniques involved in measuring and evaluating these properties, as well as an appreciation of their limitations. The paper also lists a step-by-step procedure for the preparation of electroplated specimens, and equipment needed for the measurements. Reprints from the June 1960 issue of Metal Finishing are available from *Sel-Rex Corp., Nutley 10, N.J.*

(*Continued on page 69A*)

Trade Literature

(*Continued from page 68A*)

Infrared Detectors . . .

A new technical bulletin contains concise descriptions and detailed specifications of Servotherm thermistor heat detector cells. Bulletin TB-1300-6 describes Servotherm infrared detectors for detecting temperature variations in a broad range of laboratory, industrial, or military operations that are too fast, inaccessible, hot, or rigid in specifications for direct contact with the target. Covered are three models, varying in sensitivity and application, available in a variety of standard area sizes. Model *1317*, the experimenter's model, is designed for feasibility studies and as a laboratory model. Model *1312*, stem-mounted bolometer, is made for use with reflective collector optics employed in spectrometers, infrared telescopes, and similar instruments. Model *1340*, designed for evacuation to reduce internal air swish to a minimum, is built for advanced laboratory instrument or military applications. Associated engineering drawings show Servotherm heat detector cell dimensions and internal cell construction. The bulletin also includes a section on standard flake sizes. *Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.*

Carbon Brushes for All Altitudes . . .

"Long-Life Carbon Brushes for Operation at Both High and Low Altitudes" is the title of a recently published electric equipment maintenance bulletin. Operators of aircraft have been experiencing difficulty in obtaining maximum normal life for carbon brushes and commutators or slip rings used in electric rotating machinery aboard their craft. One major cause of excessive wear is that a carbon brush will perform quite differently at lower altitudes than at higher ones. This bulletin discusses the application of a new type of carbon brush that will greatly reduce wear brought about by this action. *Advance Carbon & Electric Manufacturing Co., 2505 Mariposa St., San Francisco 10, Calif.*

Suspension Hardware for Transmission Systems . . .

"Development and Testing of Suspension Hardware for Transmission Systems," a technical paper prepared by R. A. Eucker, is now available

(*Continued on page 71A*)

FPD PROFESSIONAL EMPLOYMENT NEWS

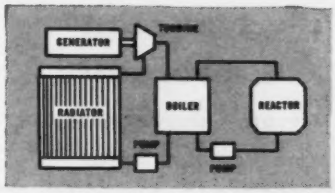
PUBLISHED BY THE FLIGHT PROPULSION DIVISION OF GENERAL ELECTRIC IN CINCINNATI, OHIO / OCTOBER, 1960

FPD NEWS offers latest information on openings throughout the Division to interested engineers and scientists. Technical information and news relating to current projects will also appear from time to time in this column.

General Electric Forms New Space Power Operation

A new Space Power Operation has been formed by the Flight Propulsion Division to consolidate advances achieved in space power and propulsion during the past 3-4 years. The move will join in a single organization the design and development of systems to power accessory equipment and electrical propulsion engines for advanced outer space vehicles.

According to FPD General Manager David Cochran, "Progress in the space power field has developed to the point where an organization of this nature can most fully utilize the technology being created." He added that the Space Power Operation would integrate new projects into company-wide space efforts.



Simplified schematic of potassium two-phase power supply. Primary loop carries heat from the reactor to boiler heat exchanger by means of high temperature, high pressure liquid metal. In the boiler, fluid flowing in the second loop is completely vaporized, expands through a turbine driving the electric generator and system pump, passes on to the radiator for condensation and return to the boiler.

Nuclear Power Stressed by Operation Manager

M. A. Zipkin, who previously guided FPD's advanced propulsion systems activities as Manager of Thermodynamics, will head the Space Power Operation. Commenting on the work of his new group, Mr. Zipkin emphasized the high efficiency potential of nuclear-powered turbomachinery.

Investigations already underway are centered on nuclear turbogenerator systems using high temperature liquid metal as the working fluid.

Other future requirements for space power systems have been defined to include power sources for manned and unmanned vehicles on interplanetary probes, lunar-based power sources, power for large orbiting satellites and powered relay communications stations.

Diversified Programs Offer Many Opportunities

Programs of continuing importance at FPD include further development of the J93 engine, to power the B-70 and the CJ-805-23 aft-fan turbojet destined to see commercial airline service next year. Progress in Lift Fan development, new engines and applications, rockets and space propulsion document the greater opportunities for professional achievement at FPD.

▸ ***Immediate Openings in Space Power Operation and Other Expanding Areas***

Liquid Metals Systems / Physical & Analytical Chemistry / Electrical Control Components Design / Engine Controls Systems Design / Thermodynamic Cycle Design Analysis / Metallurgical Engineering / Turbomachinery Design / Ion & Plasma Propulsion / Liquid & Solid Rocket Development

For more information, write informally, or forward your resume in confidence to Mr. Mark Peters, Dept. 27-MJ.

FLIGHT PROPULSION DIVISION

GENERAL ELECTRIC

BUILDING 100 CINCINNATI 15, OHIO

Professional Opportunities Are Available For

Electrical Engineers

with interest and experience in the following fields:

- Design and Development of:
  Industrial Electronics and Power Controls and Instrumentation Electronics
- Operation & Maintenance of Nuclear Devices

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Personnel Manager

Brookhaven National Laboratory

UPTON, LONG ISLAND, N. Y.

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ELECTRICAL ENGINEER

Subsidiary of major oil company operating in Eastern Venezuela has opening for a qualified Electrical Engineer:

MINIMUM REQUIREMENTS:

BSEE;

plus at least three years experience in design of process plants and medium and low voltage distribution systems, application of switchgear, protective relays, telemetering and supervisory controls.

Age to 35 years.

Liberal salary—plus allowances, bonus and other benefits.

Qualified candidates submit details experience summary and personal data to:

(MAIL BOX NO. 100)

You Must *First* Sell the Electrical Engineer!

No matter what you sell, the most important buying influence is the electrical engineer—the key RAS* Man. Only one publication is the technical spokesman for this man's industry and engineering profession—ELECTRICAL ENGINEERING. Ask your advertising manager to investigate the prime possibilities of EE's circulation. Ask him to call for the facts that will reveal depth penetration on the level that counts—the RAS* Man level.

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ENERGY CONVERSION ENGINEERS

Our Static Inverter Group has an urgent need for Electrical Engineers to work on static inverters, converters and frequency changes for military, space and frequency changes for military, space and commercial applications. Men with 4 to 8 years experience wanted wtih design/development type of background in aircraft and industrial power supplies and generating systems. Must be familiar with as many of the following as possible:

Switching characteristics of transistors, silicon controller rectifiers and four layer diodes, transformers, interstage and power.—Filters, signal level and power—Voltage regulators—Polyphase circuits—Heat transfer—Packaging—Power generating system specifications.

Challenging opportunity for engineers to do development and project work in static power supplies.

STARTING SALARY TO $12,000—MANY BENEFITS including desirable New England living, tuition plan, outstanding facilities. Reply in confidence to Box #103.

CLASSIFIED ADVERTISING

For help and situations wanted, $2.25 per line, minimum 5 lines, maximum 30 lines. Sale and purchase of used machinery, etc., $3.00 per line, not available to dealers. Address orders to: Classified Section, ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y.

When answering an advertisement, send all replies to box number specified, c/o ELECTRICAL ENGINEERING, 6th Floor, 33 West 39th Street, New York 18, N. Y., unless other address is given.

Positions Open

ELECTRICAL ENGINEER, over 35, BSEE-PE with an established consultant to take complete charge of all electric design problems in connection with buildings and to coordinate the electrical design with the mechanical engineer and architect, responsible for distribution design of utilities, municipal, REA, electric distribution systems, knowledge of industrial wiring and lighting with some knowledge of telephone design procedures or willingness to learn. Location—Southern Wisconsin. Must be aggressive and have administrative ability. Right person will have privilege of buying into company. All replies confidential. Write Box 104.

GRADUATE ASSISTANTSHIPS are available at a university in the Southeast for September, 1961. Assistants may obtain the Master of Science degree in Electrical Engineering in twelve months. Tuition free. Write to Box 99.

PROFESSOR OR ASSOCIATE PROFESSOR of Electrical Engineering to teach and do research in the field of communications. Should have Ph.D., teaching and research experience. Write Box 56.

Positions Wanted

RELAY ENGINEER—24 years of experience in all phases of relay protection for substations, power plants, and transmission facilities. Age 43. Desirous of challenging opportunity. Write Box 102.

Trade Literature

(Continued from page 69A)

in the form of a 20-page illustrated booklet. Covered are subjects related to the longevity of high-voltage transmission lines through the application of improved support hardware. Included are the following topics: hardware development, a discussion of the Preformed Armor-Grip Suspension (AGS) as a unique, thoroughly tested, and widely accepted support hardware; the fatigue problem, an analysis of the static and dynamic stresses imposed upon conductors at support points, and how stress reduction factors were examined through nondestructive and destructive testing procedures; unbalanced loading and its damaging effects as studied by exposing the AGS to static tension and impact tests; electrical characteristics of the support hardware as related to radio and television interference, as well as corona levels; field testing of the AGS over a 10-year period conducted by Preformed engineers and utility personnel. *Preformed Line Products Company, Dept. AGS, 5349 St. Clair Ave., Cleveland 3, Ohio.*

Data Sheet Describes Plug-In Dial Timer . . .

Photographs and drawings illustrate the advantages of a plug-in dial timer with exclusive safety and conversion features. Advantages of the new design include quick removal and easy replacement; heavy, plated plug-in components; a keyed guide-pin which protrudes through the rear of the case to accept a snap-in cotter pin clip to assure secure engagement as well as maximum safety; and an optional front mounting clamp for installation where rear accessibility is impractical. Engineering Data Sheet No. 87 available from *Automatic Timing & Controls, Inc., King of Prussia, Pa.*

Facsimile Communications Equipment Brochure . . .

A 4-page brochure devoted to facsimile communications equipment describes and illustrates varied equipment designed for transmitting photos, messages, data, news and other types of graphic information by means of telephone or radio links. The equipment was developed by Times Facsimile Corporation, which recently merged with Westrex Corporation. *Communications Equipment Dept., Westrex Corp., 540 W. 58th St., New York 19, N. Y.*

"Sound Systems for Schools" . . .

"Sound Systems for Schools" describes 12 standard sound systems designed to provide flexibility for meeting every school need. It explains how, through custom assembly of mass-produced components, sound equipment can be furnished to meet an almost limitless variety of functions for both large and small schools. Featured in the brochure is a description of the Medallion Language Laboratory System, including 16 detailed paragraphs covering vital features of the teacher console and student positions. Also described are automatic telephone systems and important sound components, including microphones, amplifiers, baffles, and metalware. *Dukane Corp., St. Charles, Ill.*

Tantalum Capacitor . . .

Complete technical information on the subject of wet-type tantalum capacitors is provided in a new catalog, "The Original Tantalum Capacitor," designed to give the electronic engineer all of the information he requires for his military or industrial application. The booklet contains specifications, performance characteristics, ratings, curves, and application data. Also included is an illustrated description of the company's engineered seal design. Bulletin 6.100-5 covers the company's "PP" type capacitors ranging from 325 to 1.75 microfarads, 6 to 125 maximum working voltages for operation at 85 C at full ratings. *Fansteel Metallurgical Corp., Rectifier-Capacitor Div., North Chicago, Ill.*

Stereo, Hi-Fi Guide . . .

An illustrated, 4-page booklet entitled, "Stereo and High Fidelity," includes an introduction which presents a concise, exceptionally clear definition of stereophonic sound. A discussion on the stereo sources of live broadcasting, stereo discs, and tape follows. A section devoted to stereophonic systems describes various combinations of component set-ups, using all stereo components, or all monaural components, or both stereo and monaural components. Easy-to-read diagrams illustrate each kind of set-up discussed. The booklet also reviews design principles of stereo components and gives detailed information on converting monaural equipment to stereo operation. A section on phono cartridges is also included. *Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N.Y.*

"Formica Designer's Fact Book" . . .

The 1961 edition of "Formica Designer's Fact Book," a technical reference book on laminated plastics, has been completely revised. The new 115-page edition contains property and application data covering 70 standard, special, and molding grades of high-pressure thermosetting laminating plastics, military specs, a Grade Comparator chart, tolerance and weight specifications, information on coast-to-coast fabricating facilities, Formica district office listings, additional information and data, fully illustrated. Available free to research and production engineers, designers, and purchasing agents. Send name and title on company letterhead to *Formica Corp., 4550 Spring Grove Ave., Cincinnati, Ohio.*

"Got A Problem?" . . .

Special techniques and processes available to help solve problems in production and development programs are described in a new booklet entitled "Got a Problem?" Cartoons are used to illustrate special techniques covering such processes as forging, impact extrusions, heat treating, and special assemblies. The latest techniques in flash welding, percussion welding and oxy-acetylene welding are available for highly intricate operations. The booklet is aimed specifically at helping readers with production problems, either through the manufacturer's processes already in existence, or with new processes which can be developed. *Valve Div., Eaton Mfg. Co., Battle Creek, Mich.*

X-Ray Literature Reference List . . .

A 20-page list of references spans the years from 1930 to 1960, and gives authors and publication names, and article titles and publication dates for 376 papers on X-ray analysis subjects. The reference list gives 4 entries for 1960, 35 for 1959, 44 for 1958, 49 for 1957, 63 for 1956, 45 for 1955, 32 for 1954, 34 for 1953, 24 for 1952, 7 for 1951, 35 for the period 1940-50, and 4 for the period 1930-40. *Philips Electronic Instruments, 750 S. Fulton Ave., Mt. Vernon, N.Y.*

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When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

MEN AVAILABLE

New York Office

PROFESSIONAL ELECTRICAL ENGINEER (Ontario) with 20 years' broad technical and sales experience, presently employed by the government at Ottawa desires change for a more challenging position as a technical or sales representative (electrical and electronic equipment) or any other responsible position demanding business acumen and broad technical experience. Salary, $8000 a year to start. Location preferred: Canada. E-206.

ELECTRICAL POWER SYSTEMS ENGINEER, B.S.E.E., M.B.A., P.E.-Ohio, 36. Three years' directing bulk power planning; five in distribution and substation planning; four in operation and construction of substations and plants. Now with manufacturer. Planning, coordination, reports, economics. Salary, $12,000 a year. Location open. E-207.

ELECTRICAL ENGINEER, B.S.E.E., 33. Two years' graduate training program; four and a half years' application engineer motor controllers, voltage regulators, magnetic amplifiers; one and a half years application engineer high voltage switches, fuses and metalclad switchgear; two years' sales engineer of same. Salary open. Location, U.S.A. or Foreign. E-208.

CHIEF OR CONSULTING ENGINEER, B.S.M.E. and B.A. Broad background in design, development, manufacture, application and patenting of fine mechanical and electrical products. Special experience in customer contact, organization, analysis of products and troubles. Salary, $15,000 a year. Location desired: Philadelphia or East. E-209.

Chicago Office

PLANT ENGINEER, Registered P.E., Ill., 45. Electrical-mechanical background, heavy manufacturing experience, including construction, plant layout, maintenance and operation of utilities, including power-house, and all phases of manufacturing engineering. Available immediately. Salary, $10,000-$12,000 a year. Location desired: Midwest preferred. C-1173-Chicago.

POWER SYSTEM PLANNING ENGINEER, M.S.E.E., 36. Ten years' experience analyzing power system expansion programs and writing reports to utility management for a variety of sizes and types of power systems. Thoroughly familiar with engineering economics—power system mathematics, net work analyzers; economic dispatching systems, plus some computer experience. Salary, $12,500 a year. Location, open. E-1174-Chicago.

STAFF ASSISTANT IN ENGINEERING AND FINANCE, B.S. and M.S. in E.E., 33. Ten years' experience with large electric utility. Staff assistant to the Treasurer, to Financial VP, and in office of engineering VP. Instructor of engineering economics; co-author of 3 AIEE papers. Experience in transmission line design, system planning, nuclear engineering and computers. Salary, $12,000 a year. Location desired: Chicago area. E-1177-Chicago.

PLANT ELECTRICAL ENGINEER, B.S. in E.E., 52. Seventeen years' planning and installing motors and controls, switchgear, power transformers in large industrial plant; four years' servicing electronic sound systems, seven years' GE field engineering, plus GE test course. Salary requirement, $10,500 a year. Location, open. E-1178-Chicago.

FOREMAN OF SHOP OR MAINTENANCE SUPERINTENDENT OR CHIEF ELECTRICAL, 40. Fourteen years' electrical repair and maintenance field. Know motors, controls and application AC and DC. Also transformers and sub-stations maintenance. Salary, $6600-$7200 a year. Location, South or Southwest. E-1179-Chicago.

San Francisco Office

OFFICE, FIELD, EE, 30. Seven years' experience with utility company in electrical distribution work. $7800. Prefer California or Overseas. Home: California. Se-1645.

CHIEF RESEARCH, DEVELOPMENT, EE MSPhys, 45. Nine years' experience in charge of research, develop, test, technical and administrative supervision for research laboratories working on instrumentation, measurement problems for missile programs; electronic and electromechanical devices for government agency. $16,500. Prefer San Francisco Bay Area. Home: San Francisco Bay Area. Se-1637.

MANAGEMENT, INDUSTRIAL ENGINEER, EE, MBA, 48. Production methods and inventory control supervisor and consultant major electrical manufacturer; studied production operations in every major type U.S. industry. For twenty years' headed procurement, production, planning, industrial engineering, comptroller, electronic data processing, facilities and other industrial U.S. Navy operations. $11,000. Prefer West or East Coast, Texas. Home: California. Se-1636.

INDUSTRIAL ENGINEER, PRODUCTION, SALES, MS IE, 28. Two years' work simplification, cost reduction, plant layout, materials handling, system and procedures, commercial analysis, safety engineering, liaison, planning progress, for electronics manufacturer. $7200. Prefer San Francisco Bay Area. Home: San Francisco, Se-1624.

PRODUCTION, DESIGN, 43. Fourteen years' experience in design, development, production and application engineering on power, distribution and instrument transformers. Five years' of this in administrative capacity. $9600. Prefer East and West Coast. Home: California. Se-1584.

JUNIOR ELECTRICAL ENGINEER, EE, 25. Recent grad with BS in electrical. Military completed. Would like to work as junior electrical engineer or electrical drafting. $5200 to start. Prefer San Francisco Bay Area. Home: California. Se-1516.

TRANSMISSION, OPERATION, MAINTENANCE, EE, 60. Thirty years' experience charge of power generation, transmission, marketing, contracts, operation and maintenance for utilities, irrigation and power. Also 4 years' design, development of airborne radar for military. $12,000. Prefer California, Northwest. Home: Central California. Se-1505.

DESIGN, EE, 37. Five years' self-employed manufacturing, sales of electrical components. Seven years' charge of design, production of aircraft and missile motors, controls, tape recorders, circuits, components; for manufacturer. Salary open. ANY LOCATION. Home: Illinois. Se-1484.

SALES, SYSTEMS, Math (Canada), 35. Eight years' experience sales, field installation of communication, microwave systems, for electronics manufacturers. Eleven years' telephone engineering, construction, maintenance. $9000. Prefer California, U.S. Home: Canada. Se-1460.

DESIGN ENGINEER, EE, 34. Five years' experience design and development of electrical and mechanical features of single and polyphase motors and fractional horsepower motors. $10,500. Prefer West, Southwest. Home: Ohio. Se-1437.

DESIGN, TEST, MAINTENANCE, EE, 30. One year experience design, maintenance and test on video generating equipment and test of components for video tape recorder manufacturer. $6500. Prefer San Francisco or Peninsula. Home: California. Se-1416.

TECHNICAL WRITER, RESEARCH APPLICATION, EE, 50. Excellent background component parts; very "heavy" background "printed wiring," natural writing ability. Seven years' experience in electronics, aircraft, missiles industries, including research, standardization of component parts and evaluation, circuit design, technical writing. $8000. Prefer South or California. Home: Washington. Se-1415.

DESIGN, DRAFT, DEVELOPMENT, EE, 26. Two years' of designing and building of medical equipments such as blood flow meter, liquid drop counter, automatic temperature control chamber, defibrilator, etc. $5400. Prefer San Francisco Bay Area. Home: California. Se-1413.

INSTALLATION, SERVICE, EE, 29. Four years' installation and service engineer, in power and industrial electronic fields. One year industrial tube application engineer, computer circuits and tubes. One year overhead distribution engineer with utility. Six months' industrial equipment design engineer. $7580. Prefer West Coast. Home: Washington. Se-1399.

RESEARCH, DEVELOPMENT, PhD EE, 36. Seven years' experience research, development on high voltage utility equipment, underground cable accessories, and electrical circuit breakers. Also one year operation of hydro electric power plants for utility. $10,800. Prefer San Francisco Bay Area, Chicago. Home: Illinois. Se-1398.

SENIOR TRANSMISSION ENGINEER, MSEE (Germany), US citizen, 51. Twenty-five years' experience design, planning power transmission and distribution, both foreign and domestic, for power plants, utility, metallurgical and chemical plants, river projects, airbases; for consultants, government, engineering builders. $12,000. Prefer Pacific or East Coasts. Home: San Francisco East Bay. Se-1385.

SENIOR DESIGN DEVELOPMENT, EE, 36. Eleven years' experience well grounded manufacture electrical apparatus including switchgear and circuit breakers. Strong background in design, development, laboratory and short-circuit testing. $11,000. Prefer San Francisco Peninsula. Home: California. Se-1378.

(Continued on page 74A)

3rd National Conference

ON ANALOG AND DIGITAL INSTRUMENTATION

March 1959

This conference was planned to provide a review of the progress made in instrumentation technology. Publication T-113 is the record of the conference held at Philadelphia, Pa., April 20-21, 1959. Sponsored by the Recording and Controlling Instrumentation Committee of the AIEE, the 279-page publication contains 31 of the papers presented at the meeting which was divided into the following sessions:

1. Engineering Education for Instrumentation
2. Electronic Analog Recorders
3. Computer Control Systems
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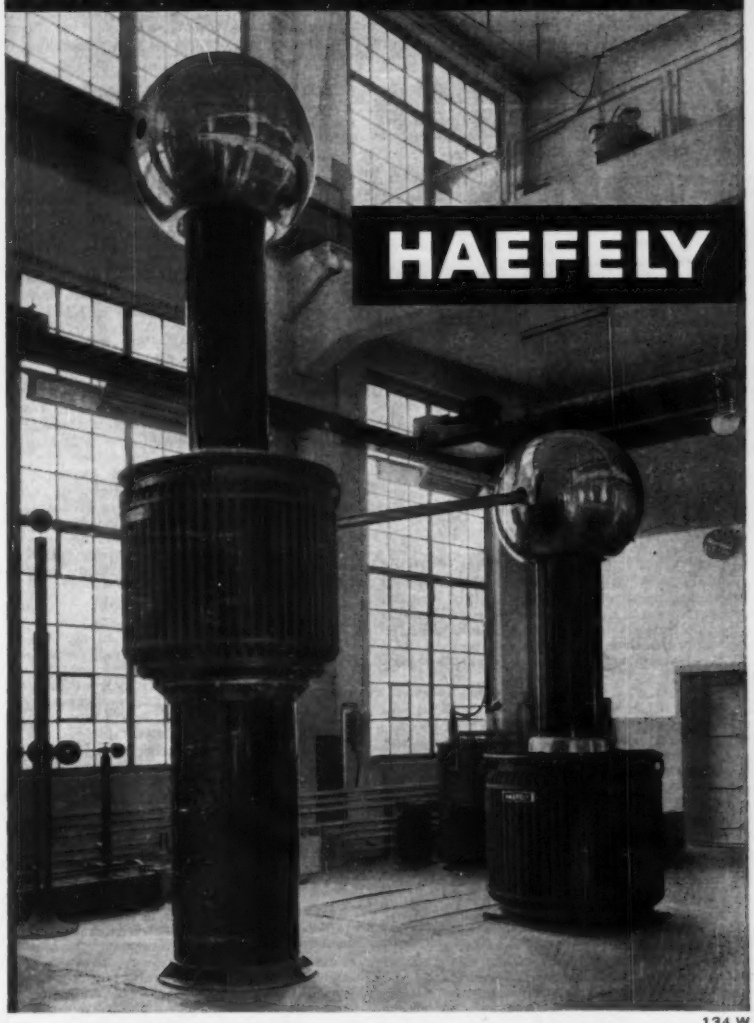

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(Continued from page 72A)

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ELECTRICAL DESIGNER, MSc EE (Poland), 49. Extensive design and development in substation, switching and generating stations design and construction. $9000. Any location. Home: New York. Se-1372.

MAINTENANCE, CONSTRUCTION SUPERVISOR, EE (Cuba), 40. Eighteen years' experience in construction, maintenance and engineering for metallurgical plant and industrial facilities in different plants in Latin America. Twelve years with large size American metallurgical plant. Supervisory experience on various type of heavy industrial electrical and mechanical equipment. English and Spanish fluently. Prefer domestic or foreign (Spain or Latin America). Salary open. Se-1343.

DESIGN, SALES, EE, 25. Two years' experience in construction and design of overhead distribution lines. Desire broader experience and more challenging position with power utility or manufacturer of utility equipment. $7200. Prefer U.S., Alaska, Hawaii. Home: Texas. Se-402.

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PROJECT PLANT ENGINEER, 25-35, B.E.E. or B.M.E. degree, with about five years' experience on equipment used in the manufacture of electrical insulated or coated products. Will be responsible for projects involving equipment, including design, specifications, estimates and completion of engineering projects. Salary, $7200-$8400 a year. Location, central New Jersey. W9475.

ASSOCIATE EDITOR, Engineering, at least a B.S. in E.E., with several years' engineering experience for an electrical utility or for a manufacturer or consultant doing electrical utility work. Should be conversant with a broad range of utility technical problems, including system design, transmission, generation, distribution and economics. Will originate, write and edit own stories; responsible for watching trends; aid in technical meeting coverage. Extensive travel. Salary, $7000-$10,000 a year. Location, New York Metropolitan area. W9474.

EDITORIAL PERSONNEL. (a) Assistant Editor, electronics, college graduate, with an electrical or communications engineering background or solid reporting background, to report and write about electronics covering electronics industry. Some writing and editing, some technical reporting. Prefer experience on industrial paper. (b) Editorial Assistant, young, college graduate, with some experience or education in journalism, to work as reporter on a weekly newsletter. Will develop and write stories, interview people; will cover all activities related to gathering of news in atomic field. Salaries: (a) to $8500 a year depending upon experience; (b) to $7000 a year depending upon experience. Location, New York Metropolitan area. W9462.

ELECTRICAL POWER ENGINEER, with five to ten years' experience on process and industrial chemical plant projects, experienced in power plant, substation and distribution systems for large industrial, process and utility projects. Work involves responsibility for design, preparation and specifications and requisitions for electrical equipment, lighting and control work. Salary, $8000-$12,000 a year depending upon qualifications and experience. Location, eastern Pennsylvania. W9452(a).

ASSISTANT EDITOR, graduate in electrical or mechanical engineering, or a degree in physics, with one to two years' experience with a manufacturer of electrical or electronic products in some design engineering function, including test or development lab. Some technical writing experience desirable. Will edit new product releases from suppliers of new components, materials and lab test equipment, used in development of electrical/electronic products; review literature; write brief news items, etc. Trainee position. Salary, $6000 a year. Location, New York City. W9444.

ELECTRICAL PRODUCT ENGINEER, electrical graduate, with at least five years' industrial electronic experience for work on fire detection devices. Salary, $8000-$10,000 a year. Location, New Jersey. W9440(a).

ELECTRICAL ENGINEER, graduate, who has had experience as inspector of construction of relatively small diesel engine electric generator plants, outside electrical distribution systems and interior illumination wiring. Installations to be inspected are for small communities. Must understand, read and write French. Salary, $11,000 a year, plus $300 per month living allowance. Location, Far East. F9427.

ENGINEERS. (a) Design Engineer, graduate electrical, for training in the design of special and new types of transformers. Should have analytical mind. Salary open. (b) Transformer Design Engineer, for the design of all kinds of special transformers. Salary, $10,000 a year. Location, western Pennsylvania. W9421.

DESIGN ENGINEER, graduate electrical, with three to five years' experience in electromechanical design. Knowledge of electricity and conventional electronics. Knowledge of heat transfer and thermal engineering desirable. Company will pay placement fee. Salary, to $8400 a year. Location, Long Island, New York. W9420(a).

INSTRUCTOR in electrical engineering, M.S. or Ph.D. degree, with interest in electrical machinery desirable. Some graduate teaching in evening program. Appointment on 12-month basis with one month vacation. Rank and salary dependent upon qualifications. Location, Midwest. W9416.

ELECTRICAL ENGINEER, graduate preferred, but not required if equivalent experience is indicated. Experience in the design and layout of power distribution systems required. This includes selection of switchgear and layout on motor control centers. Should have experience in plant lighting systems. Salary, $10,000-$13,000 a year. Company pays placement fee. Location, New York City. W9400.

PROFESSORS, recent Ph.D.'s or equivalent, for positions involving teaching and research in electrical engineering. Areas of interest are servomechanics, microwaves, advanced electronics, semiconductors and computers. Excellent salaries, consulting, liberal research compensation and fringe benefits. Semi-urban university located in upstate New York. W9368.

ENGINEERS. (a) Motor Designer, graduate electrical with good experience in the design of sub-fractional 1/50 to 1/4 AC and DC hp motors as used in the automotive field. Salary high. (b) Electro-Mechanical Designer, graduate, with experience in thermostats, heating devices as used in irons, toasters, electric blankets, etc. Salary high. Location, Connecticut. W9358.

ASSISTANT TO PRESIDENT, under 40, graduate, preferably electrical, with MBA degree; three to five years' experience as staff administrator on new products, electronic components, planning for long range; marketing experience. Should be cost conscious; have systems and procedure experience. Salary, $10,000-$12,000 a year. Location, northern New Jersey. W9350.

Chicago Office

SALES ENGINEER, graduate electrical; age to 40; to sell heavy outdoor switches. Must have four or more years' utility experience, either in design or operation. Must have sales personality. Travel about 25% of time through Northern Illinois and Eastern Iowa; car furnished. Employer will pay placement fee. Salary, $9600-$10,800 a year. Location, Chicago. C8248.

LIAISON SALES ENGINEER, graduate electrical, with two or more years' experience in production engineering or sales. Duties: Sales engineering on potentiometers, pressure instruments, accelerometers, gyros or similar components. Midwest territory for a manufacturer. Salary, $7200-$9600 a year plus bonus. C8241.

ELECTRONICS LABORATORY DIRECTOR, preferably Ph.D.; experience and maturity required. Duties: To direct the development of radically new processes and products in the fields of metal, paper, plastics and glass containers and materials, utilizing electronics and related sciences. Some travel, no car required. Salary, $12,000-$15,000 a year. Employer will pay placement fee. Location, Chicago. C8221.

San Francisco Office

MANAGER OF RESEARCH AND ENGINEERING, PhD EE or Phys, 30-40. Five to eight years' in field of computers and/or electronic equipment of digital nature. For all aspects of engineering, research and development, establish and maintain department policies, on new products to be developed for marketing. $18,000-25,000. Southern California. Sj-5506.

COST ESTIMATOR, IE or BusA and five to seven years' experience or equivalent. Prepare cost estimates of machine shop, sheetmetal and electronic assembly shops labor hours from blueprints and/or models along with estimating raw stock, packing and tooling dollars. Also including purchased parts prices, test equip costs and engineering design and assist costs supplied by departments. All estimates and costs then correlated into total cost of unit. Detailed analysis of and familiar with unit in question and coordinate of all contributing departments. Also method improvement, budgets, time standards, special reports. Employer pays placement fee. Salary open and interviews arranged. Apply by letter with experience and salary expected. For electromechanical manufacturer systems electronic equipment. Southern California. Sj-5487.

DESIGN, Degree Electronics and at least two years' experience on special test equipment design. For design of new equipment, redesign of existing equipment to new specifications and justifying all types of standard commercial test equipment for manufacturing, engineering and research groups. Design capabilities of in-plant test equipment and experience in writing test procedures from preleased engineering specifications. Personal interviews arranged, company will pay employment placement fee. Apply by letter with education, experience and salary requirement. Southern California. For manufacturer. Sj-5458.

ADVANCED CIRCUIT DESIGN, graduate degree. Recent solid experience in system design and analysis of electronic rotating power conversion equipment including machinery and control; combination of power and electronics at several levels. Starting salary at $8400-14,000, or substantially more for high level supervisory engineer. For a manufacturer. Ohio. Sj-5477.

SENIOR TECHNICAL WRITERS, BS Engrg, Physics or Math & three years' experience (or education) in design, installation, operating modern electronic equipment, preferably transmitters, receivers, radars or computers, or experience in journalism, reports, instruction books. Plan, write and edit R&D reports on system studies, equipment engineering, verify report and manual material, adopt at precise, concise writing. $6600-10,500. Sj-5472-R.

DESIGN, Graduate with two to five years' engineering experience, one to two years' experience in electromechanical equipment design and assembly preferred. Must be able to work with hands and operate conventional shop tools. Employer will pay fee. For manufacturer of high quality stereophonic tape recorders and sound system for the consumer market. $6600-8700. San Francisco Peninsula. Sj-5470-R.

DESIGN, MAINTENANCE, EE, to five years' design and/or maintenance experience and potential and desire to advance to management positions. Plant extracts elemental phosphorous from phosphate shale through electrical furnace process. Operate four electrical furnaces and have force of 450 personnel. Salary open. Northwest. Sj-5460.

(Continued on page 75A)

(*Continued from page 74A*)

INSTRUMENT ENGINEER, Ch, EE or ME and five years' experience in refinery and chemical plant instrumentation. Experience in nuclear reactor instrumentation advantageous. To engineer systems and write specifications for basic instruments, constrol systems, safety interlocks and relief systems for refineries, chemical plants and nuclear reactors. $7500-10,200. U. S. citizen. Southern California. Sj-5455.

DEVELOPMENT, DESIGN, age open, EE. Several years' experience in advanced electronics instrument development (vacuum tube and transistor circuitry) for analog and digital. Packaging experience desirable; for manufacturer. Salary open. Sj-5446-R.

DESIGN, Minimum five years' electrical equipment design experience including some supervisory work. Able to plan and design eletcrical powered three phase equipment including high voltage (20,000 volts-300 KW), disconnects, circuit breakers, controls, relays, overloads, timers. Must be able to design for manufacturer and installation. Some knowledge of electron beam effects (tube, filament, cathodes). For manufacturer of electrical furnaces. $8400-9000. San Francisco East Bay. Sj-5446.

INSTRUMENTATION DESIGN, EE, ME or equivalent. At least five years' experience application and systems design of instrumentation for chemical, petrochem or petrolcum plants. Should be able to provide complete design function with minimum supervision. Salary commensurate. Relocation allowance and employer will pay placement fee. For engineering builder. San Francisco. Sj-5440.

MAINTENANCE SUPERINTENDENT, EE or equivalent. To supervise maintenance personnel on one-river, multi-plant integrated hydro operation. Supervise operation of new plant in addition to maintenance, involving plant electrical system, substation and transmission line maintenance, mechanical maintenance of generating of auxiliary equipment, roads, grounds maintenance and debris removal from lakes. Start $6600-$7200, depending on experience plus modern house at nominal rent. Pacific Northwest. For utility. Sj-5412.

ENGINEERING ASSISTANT, EE, some experience helpful. Must be capable of handling concurrent and diversified assignment through to accurate and intelligent completion, involving budget evaluation, investigation of proposed projects, calculate and assembling of data, field and office research. $6384 with opportunity for advancement. Pacific Northwest. Sj-5410.

DESIGN, at least two years' experience in design of digital data systems. EE, no age limit. To design digital computer systems. $7200-9600 depending on experience, plus profit sharing bonuses. San Francisco East Bay. Sj-5409.

DEVELOP, DESIGN, MS or BSEE, five years' experience preferred. To develop DC power supplies involving mag-amp, silicon controlled rectifiers, transistor control three to 1500 ampere ratings. For use in shipboard missile and aircraft, industrial plants, commercial airlines, electrical vehicles, utility companies, commercial service stations and oil companies, theaters. $8000-14,000, depending on experience plus fringe benefits. Southern California. For manufacturer. Sj-5408-R.

SALES, ESTIMATE, TAKE-OFF, Experienced man to take off and estimate on electrical equipment such as cable trays, power structures and possibly metal petitioning for industrial commercial and general use. Should be able to deal with engineers, architects and owners and to assist in preparation of specifications and developing layouts for clients. Drawing account, liberal commission. Potential to $10,000 in developed territory. For manufacturers' agent. San Francisco Bay Area. Sj-5404-R.

(a) **PRELIMINARY DESIGN**, Analysis of both ballistic missiles and advanced space vehicles from control guidance and performance viewpoint, stressing propulsion system application. Two to eight years' related experience. Salary open. San Francisco Bay Area. Sj-5391.

(b) **PROPULSION ENGINEERS**, analysis and preliminary design of new types of proulsion system. Approximately ten years' related work experience required. Salary open. San Francisco Bay Area. Sj-5391.

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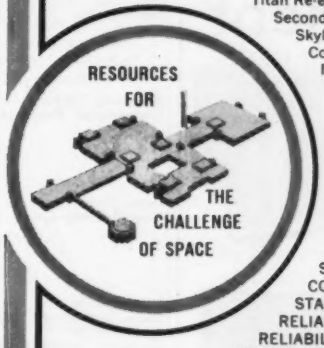

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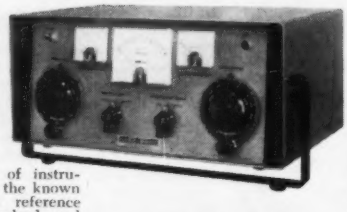

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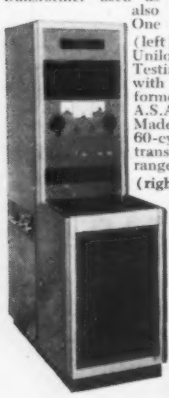

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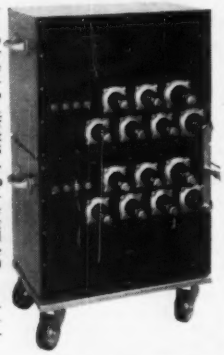

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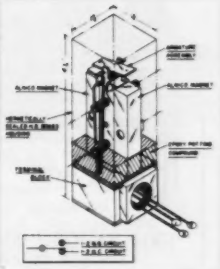
the hermetically-sealed GO Proximity Limit Switch is, indeed, impervious to weather and other climatic conditions as well as oils and coolants. Other reasons why you should investigate this dynamic new product:

*Apologies to Herodotus, Greek Historian.

- **Combines the best characteristics of the mechanical switch and the proximity switch system.**
- **Operates completely without physical contact with its actuating means.**
- **Operates in external magnetic fields; reliable; fail safe; will not false-trip; highly resistant to demagnetizing forces.**
- **Unlimited over-travel and actuating capabilities.**
- **Fast actuation — 3,600 sinusoidal operations per minute.**
- **No operating arms, springs, etc. to wear or break; long life expectancy.**
- **Excellent sensitivity.**
- **Small differential; accurate repeatability.**
- **Reduce downtime and maintenance cost.**



Examples of parts that can be detected by the GO Proximity Limit Switch:

Bottle Caps, Cans, Gears, Wheels, Conveyor Hangers, Oven Doors, Motor Housing and Bearings.

Examples of Applications:

Counting Operations, Assembly Operations, Safety Devices, Flow Switch Operation, Operation of Solenoid Valve, Activation of Paint Spray Gun, Control of Unloading and Transfer Conveyors and dozens of other uses.

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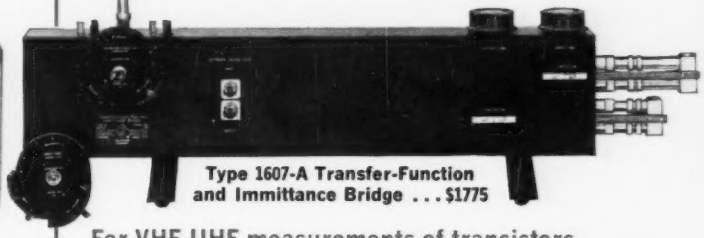

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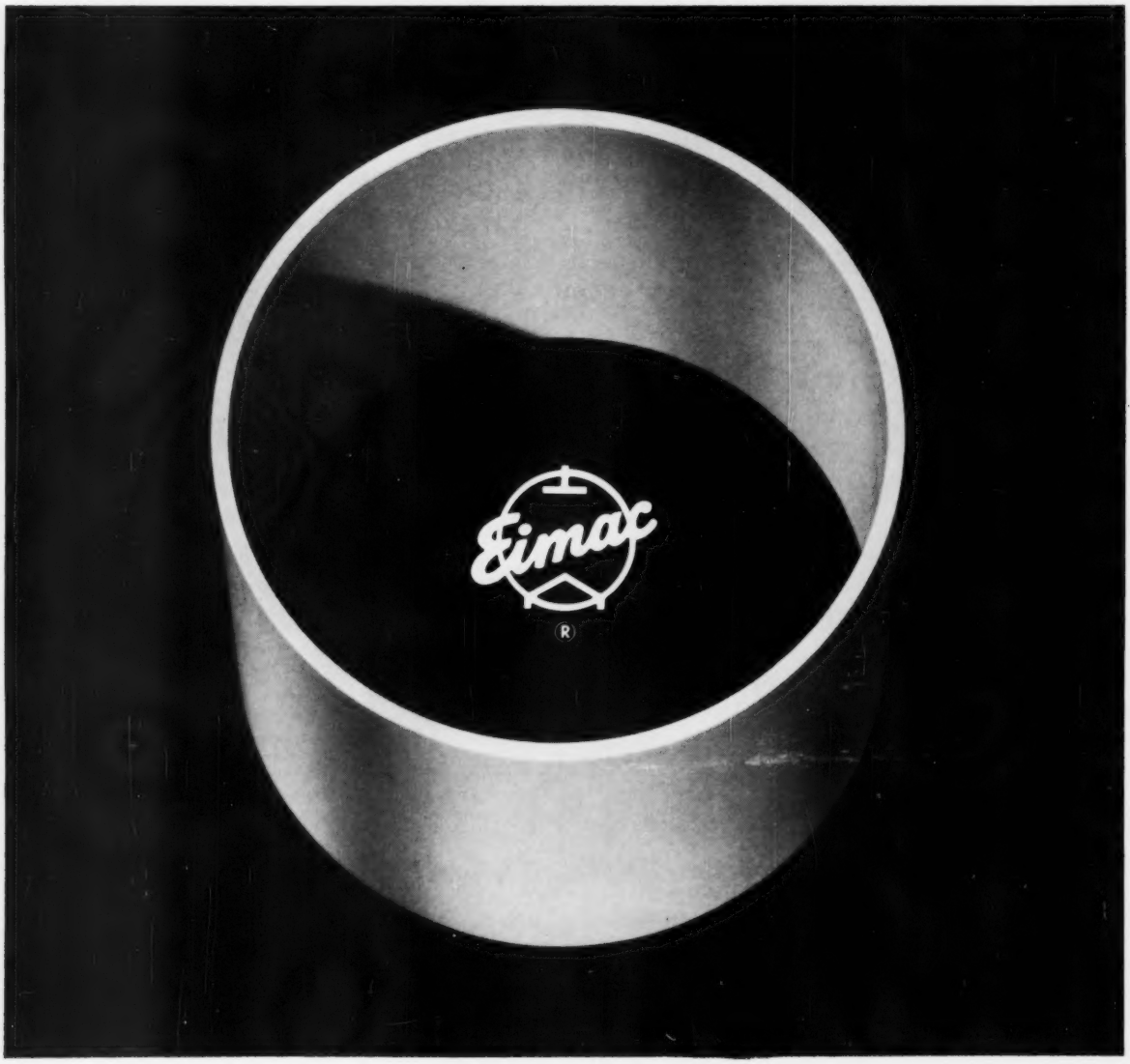
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